POLICY UPDATE

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SUMMARIZES REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE

Australia's new Euro 6d-equivalent emission standards for light vehicles

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INTRODUCTION

On April 9, 2024, Australia strengthened its exhaust and evaporative emission standards for light-duty vehicles by adopting Euro 6d-equivalent requirements.[1] The new standards apply to all passenger vehicles (the MA, MB, MC, MD1, and MD2 categories defined in the Road Vehicle Standards Act 2018) and light commercial vehicles (NA category) with gross vehicle mass of 3.5 tonnes or less.[2]

The standards will apply beginning on December 1, 2025, for new models of vehicles that enter the Australian market for the first time on or after that date. For models that entered the Australian market before December 2025, the standards will take effect July 1, 2028, for vehicles registered for the first time on or after that date. This time frame was chosen to align the transition from Euro 5 to Euro 6d-equivalent standards with Australia's improved fuel quality requirements that apply starting on December 15, 2025.[3] These fuel quality standards include reduced limits for sulfur and aromatic hydrocarbons which are a prerequisite for Euro 6d-compliant vehicles.[4] The new regulation will also accept type-approval test results compliant with the U.S. Environmental Protection Agency (EPA) Tier 3 standards for light-duty vehicles.

Euro 6 emission standards became mandatory for new vehicles in the European Union in September 2014.[5] The Euro 6d stage, which has been mandatory for new vehicles in the European Union since September 2017, replaces the former New European Drive Cycle (NEDC) procedure with the Worldwide harmonized Light-vehicles Test Procedure

1 "Vehicle Safety and the Environment," Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, accessed August 5, 2024, https://www.infrastructure.gov.au/infrastructure-transport-vehicles/vehicles/vehicle-safety-environment.

2 Vehicle Standard (Australian Design Rule – Definitions and Vehicle Categories) 2005, Federal Register of Legislation, September 29, 2023, https://www.legislation.gov.au/F2005L03850/latest/text.

3 "Regulating Australian Fuel Quality," Australian Government Department of Climate Change, Energy, the Environment and Water, accessed August 5, 2024, https://www.dcceew.gov.au/climate-change/emissions-reduction/regulating-fuel-quality#toc_0; Australian Government Department of the Prime Minister and Cabinet, *Improving Australia's Fuel and Vehicle Emissions Standards–Final Impact Analysis*, accessed August 5, 2024, https://oia.pmc.gov.au/published-impact-analyses-and-reports/improving-australias-fuel-and-vehicle-emissions-standards.

4 The standards limit aromatic hydrocarbons to 35% or lower in premium unleaded (95 Research Octane Number) and gasoline and sulfur content to 10 ppm in all gasoline grades starting on December 15, 2025.

5 European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, *Euro 6/VI Evaluation Study* (Publications Office of the European Union, 2022), https://data.europa.eu/doi/10.2873/933978.

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(WLTP) and also expanded the scope of emissions testing to include real-world driving conditions.[6] Subsequently, in July 2023, the first stage of Euro 6e was introduced and became mandatory.[7] Beginning at the end of November 2027, Euro 7 emission standards will apply in the European Union. Euro 7 introduces particle emission limits for brakes and tires, sets durability requirements for batteries, and extends vehicle useful life requirements.[8]

This policy update details the Euro 6d-equivalent requirements adopted by Australia and highlights both the improvements compared with the country's former Euro 5-equivalent standards and the differences with the more advanced Euro 6e and Euro 7 standards.

OVERVIEW OF THE NEW STANDARDS

Australia's new emission standards were adopted via three Australian Design Rules (ADRs) incorporated into the Road Vehicle Standards Act 2018 (Table 1).[9] They are based on the internationally harmonized vehicle regulations adopted by the United Nations Economic Commission for Europe (UNECE). The following sections discuss the scope and requirements in detail.

Table 1

New emission regulations adopted in April 2024 under the Road Vehicle Standards Act 2018

ADR number – name	Regulatory scope	Adopted from	Notes/exceptions
111/00 —Advanced Emission Control for Light Vehicles (adopting the improved laboratory tests mandated in Euro 6d)	WLTP test requirements for tailpipe emissions of criteria pollutants, measurements of CO_2 emissions, fuel consumption and/or electric energy consumption and electric range, evaporative emissions, and durability of pollution control devices. On-board diagnostics (OBD) system and on-board monitoring requirement.	UNECE regulation 154 (Revision 1, Amendment 2)	4-phase WLTP test requirements apply, but flexible to 3-phase tests as long as compliant with 4-phase WLTP emission limits; Euro 6d in-service conformity test requirements not needed.
112/00 — Control of Real Driving Emissions for Light Vehicles (adopting the on-road emissions test mandated in Euro 6d)	Real-world driving emissions (RDE) test requirements (with two major exceptions from the respective Euro 6e-equivalent UN regulation in test ambient temperature conditions and PEMS conformity/margin factors, to align with Euro 6d requirements).	UNECE regulation 168 (representing Euro 6e level)	Moderate temperature test: 0 °C to 30 °C (instead of 0 °C to 35 °C) Extended temperature test (upper range): 30 °C to 38 °C (instead of 35 °C to 38 °C) Euro 6d PEMS conformity factors: 1.43 for NO_x (instead of 1.10) 1.5 for PN (instead of 1.34)
79/05 —Emission Control for Light Vehicles)	Implementing regulation for Euro 6d-equivalent standards, specifying requirements for all three ADRs 79/05, 111/00, and 112/00; alternative standards (U.S. Tier 3). Technical descriptions for idling emissions, crankcase emissions, and exhaust emissions at low ambient temperature.	UNECE regulation 83 – Revision 5 – Amendment 17 (08 series of amendments)	–

6 European Commission, *Euro 6/VI.*

7 Jan Dornoff, *Euro 6e: Changes to the European Union Light-Duty Vehicle Type-Approval Procedure* (International Council on Clean Transportation, 2022), https://theicct.org/publication/euro6e-type-approval-dec22/

8 Jan Dornoff and Felipe Rodríguez, *Euro 7: The New Emission Standard for Light- and Heavy-Duty Vehicles in the European Union* (International Council on Clean Transportation, 2024), https://theicct.org/publication/euro-7-emission-standard-ldv-hdv-eu-mar24/; Regulation (EU) 2024/1257 of the European Parliament and of the Council of 24 April 2024 on type-approval of motor vehicles and engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7), amending Regulation (EU) 2018/858 of the European Parliament and of the Council and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009 of the European Parliament and of the Council, Commission Regulation (EU) No 582/2011, Commission Regulation (EU) 2017/1151, Commission Regulation (EU) 2017/2400 and Commission Implementing Regulation (EU) 2022/1362 (Text with EEA relevance), OJ L 8.5.2024, http://data.europa.eu/eli/reg/2024/1257/oj.

9 Australian Government, "Vehicle Safety."

IMPROVED LABORATORY TEST PROCEDURE

ADR 111/00 adopts the Euro 6d requirement of using the WLTP for laboratory tests, which replaces the NEDC test procedure from the Euro 5-equivalent standard (ADR 79/04).[10] WLTP was developed to better reflect real-world driving conditions; emissions are more representative of real-world operations than those assessed via the NEDC.[11] WLTP will be used for determining the emissions of criteria pollutants, carbon dioxide (CO_2) emissions and fuel consumption, electric energy consumption, and electric range in the laboratory.

There are two possible approaches to the underlying Worldwide harmonized Light vehicle Test Cycle (WLTC) used for type-approval. One is the 4-phase WLTC, used in the European Union, with four phases of different average speed values: low, medium, high, and extra high. The other is the 3-phase WLTC, used in Japan, which consists of only the first 3 phases and omits the additional high phase. The requirements for the 4-phase and 3-phase tests are differentiated in UN Regulation 154 as Level 1A and Level 1B requirements, respectively. The new Australian regulations adopt the Level 1A requirements, but also accept Level 1B test results that comply with the Euro 6d emission limits and durability requirements. Allowing the Level 1B test procedure grants flexibility in importing vehicles from countries like Japan.

EMISSION LIMITS

Emission limits are differentiated by vehicle and fuel type. Table 2 compares the Euro 6d limits adopted in the ADR 111/00 for criteria pollutants with the former Euro 5 standards (ADR 79/04). Values in green indicate improvement in the new standard compared with the former.

The major improvements include more stringent limits for NO_x (nitrogen oxides) and THC+NO_x (total hydrocarbons plus nitrogen oxides) for diesel vehicles. Another improvement is the introduction of a particle number (PN) limit—a limit on the number of particles 23 nm or larger—for gasoline vehicles fitted with gasoline direct injection (GDI); this previously applied only to diesel vehicles in the Euro 5 standard. Euro 6d limits reduce diesel NO_x emissions by about 55% and THC+NO_x emissions by approximately 26% and 39% for diesel passenger vehicles and light commercial vehicles, respectively, compared with the Euro 5 limits. The PN limits for diesel and gasoline vehicles include particle sizes as small as 23 nm. Limits for other pollutants, including particulate matter (PM) and NMHC (nonmethane hydrocarbon), remain the same as under Euro 5.

10 Vehicle Standard (Australian Design Rule 79/04 — Emission Control for Light Vehicles) 2011, Federal Register of Legislation, April 13, 2024, https://www.legislation.gov.au/F2011L02016/latest/text

11 European Commission, *Euro 6/VI*; Martin Williams and Ray Minjares, *A Technical Summary of Euro 6/VI Vehicle Emission Standards* (International Council on Clean Transportation, 2016), https://theicct.org/publication/a-technical-summary-of-euro-6-vi-vehicle-emission-standards/.

Table 2

Former Euro 5 and the new Euro 6d emission limits for Australia's light-duty vehicles

Vehicle type	Pollutant	Euro 5 limits in NEDC		Euro 6d limits in WLTP	
		Gasoline	Diesel	Gasoline	Diesel
Passenger vehicles	CO (mg/km)	1,000	500	1,000	500
	THC (mg/km)	100	—	100	—
	NMHC (mg/km)	68	—	68	—
	NO_x (mg/km)	60	180	60	**80**
	THC+NO_x (mg/km)	—	230	—	**170**
	PM (mg/km)[a]	4.5	4.5	4.5	4.5
	PN (#/km)[a]	—	6.0×10^{11}	**6.0×10^{11}**	6.0×10^{11}
Light commercial vehicles	CO (mg/km)	2,270	740	2,270	740
	THC (mg/km)	160	—	160	—
	NMHC (mg/km)	108	—	108	—
	NO_x (mg/km)	82	280	82	**125**
	THC+NO_x (mg/km)	—	350	—	**215**
	PM (mg/km)[a]	4.5	4.5	4.5	4.5
	PN (#/km)[a]	—	6.0×10^{11}	**6.0×10^{11}**	6.0×10^{11}

Note: Values in **green** indicate improvement in the new standard compared with the former.
[a] PM and PN limits for gasoline vehicles apply for gasoline direct injection (GDI) vehicles only.

In the European Union, the same numerical emission limits from Euro 6d are carried over to the new Euro 7 standards. However, Euro 7 expands the scope of PM and PN limits in two ways: (1) to all gasoline vehicles, regardless of the fuel injection method; and (2) by including particles with diameters down to 10 nm in the PN count compared with diameters of 23 nm covered by Euro 6.

REAL-WORLD DRIVING TEST REQUIREMENT

ADR 112/00 introduces the Euro 6d-equivalent Real Driving Emissions (RDE) test requirements. RDE tests are performed on public roads, but are restricted by requirements for vehicle speed profile, ambient conditions, and other boundary conditions. Carbon monoxide (CO), NO_x, and PN emissions are measured onboard using a portable emissions measurement system (PEMS), but the CO measurement is only for monitoring. The measured NO_x and PN emission values are divided by pollutant-specific PEMS margins to account for measurement uncertainties compared with the laboratory. Thus, the higher the margin factor, the greater the effect of lowering the stringency level of the limits for RDE measurements. For compliance with Australian requirements, the PEMS-margin-adjusted RDE results for NO_x and PN must meet the Euro 6d emission limits shown in Table 2.[12]

ADR 112/00 adopted the Euro 6d PEMS margin values, 1.43 for NO_x and 1.5 for PN, but the latest evidence of PEMS accuracy led to a PEMS margin reduction in the Euro 6e standards to 1.10 for NO_x and 1.34 for PN. Although ADR 112/00 largely adopted UNECE regulation 168, which includes the margin factors equivalent to the updated Euro 6e levels, ADR 112/00 amends the requirement to remain at Euro 6d levels to allow import of Euro 6d-compliant vehicles.

12 CO emissions are measured in RDE tests, but they are not subject to any limits.

For RDE ambient temperature thresholds, ADR 112/00 sets a mix of Euro 6d and Euro 6e requirements. It amends UNECE regulation 168 by keeping the Euro 6d moderate temperature range of 0 °C to 30 °C instead of using 0 °C to 35 °C, and defines the upper extended temperature range as 30 °C to 38 °C instead of 35 °C to 38 °C.

Euro 6e includes stages that make an important adjustment for plug-in hybrid electric vehicles (PHEVs), to reflect a more realistic electric drive share and CO_2 emissions for PHEVs than is reflected in Euro 6d. The adjustment is based on evidence that real-world CO_2 emissions of Euro 6d PHEVs are 3 to 5 times higher than WLTP type-approval emission values.[13] This is caused by the high and unrepresentative electric drive share assumed in the Euro 6d regulation, which weights CO_2 emissions based on the share of driving using the electric battery versus the internal combustion engine. The assumed electric drive share depends on the electric range of a PHEV and is reflected in the utility factor curve. In Euro 6e, the utility factor curve is adjusted downward in two steps, and PHEVs are required to have a substantially larger electric range to get assigned the same electric drive share in Euro 6d.

ON-BOARD DIAGNOSTIC (OBD) REQUIREMENTS

On-board diagnostic (OBD) systems are used to monitor the functioning of powertrain systems and components that effect exhaust emissions to identify possible malfunctioning. OBD thresholds are numerical emission limits used to flag any malfunctions or anomalies in the system. ADR 111/00 adopts the more stringent OBD thresholds in Euro 6d to allow earlier detection of possible malfunctions or irregularities in the emission control system. Table 3 shows that Euro 6d lowers the OBD thresholds by 76% for PM, 70%–74% for NO_x, 9%–33% for NMHC, and 8%–11% for CO (for diesel vehicles) compared with Euro 5.

Table 3
OBD thresholds in Euro 5 and Euro 6d

Vehicle type	Pollutant	Thresholds in Euro 5 (mg/km)		Thresholds in Euro 6d (mg/km)	
		Gasoline	Diesel	Gasoline	Diesel
Passenger vehicles	CO	1,900	1,900	1,900	**1,750**
	NMHC	250	320	**170**	**290**
	NO_x	300	540	**90**	**140**
	PM	50	50	**12**	**12**
Light commercial vehicles	CO	4,300	2,800	4,300	**2,500**
	NMHC	400	400	**270**	**350**
	NO_x	410	840	**120**	**220**
	PM	50	50	**12**	**12**

Note: Values in **green** indicate improvement in the new standard compared to the former.

13 Patrick Plötz et al., *Real-World Usage of Plug-In Hybrid Vehicles in Europe: A 2022 Update on Fuel Consumption, Electric Driving, and CO_2 Emissions* (International Council on Clean Transportation, 2022), https://theicct.org/publication/real-world-phev-use-jun22/; European Commission, *Commission Report Under Article 12(3) of Regulation (EU) 2019/631 on the Evolution of the Real-World CO_2 Emissions Gap for Passenger Cars and Light Commercial Vehicles and Containing The Anonymised and Aggregated Real-World Datasets Referred to in Article 12 of Commission Implementing Regulation (EU) 2021/392*, March 18, 2024, https://climate.ec.europa.eu/document/download/b644dafe-1385-4b56-98d9-21e7e9f3601b_en?filename=report.pdf

Euro 6e-bis—the second stage of the Euro 6e implementation—includes an additional requirement for OBD to flag unauthorized activity of auxiliary emission strategies (AES).[14] Furthermore, the Euro 7 standard will introduce on-board emissions monitoring—a compliance verification device—for monitoring NO_x and PM emissions and for recording when applicable emissions limits are exceeded by a factor of 2.5 or more. The data will be accessible via the OBD interface, and the detection of limits being significantly exceeded will trigger a driver warning system to ensure a timely repair.

ON-BOARD FUEL AND ENERGY CONSUMPTION MONITORING REQUIREMENT

ADR 111/00 introduces the Euro 6d requirement for on-board fuel and energy consumption monitoring (OBFCM) devices for all new light-duty vehicles with internal combustion engines, including PHEVs. The OBFCM device collects real-world fuel and energy consumption data. The data is used to analyze the gap between real-world and type-approval CO_2 emissions and, potentially, to develop mechanisms to counteract any future widening of the gap. Euro 7 extends the scope of OBFCM to all vehicle categories and powertrains including battery electric vehicles, which were not included in Euro 6d or Euro 6e.

EVAPORATIVE TEST PROCEDURE

Evaporative emissions from the fuel tank of gasoline vehicles are regulated. Following the Euro 6 requirements, the Euro 5 evaporative emissions limit of 2 g HC per test is carried over to the ADR 111/00 and the test duration is doubled to 48 hours (Table 4). In the Euro 7 standard, the emission limit has been lowered to 1.5 g HC per test.

Table 4
Evaporative emissions test requirements for gasoline vehicles only

Standards	Euro 5	Euro 6d/6e	Euro 7
Test duration (hours)	24	48	48
HC limits (grams)	2.0	2.0	1.5

DURABILITY/VEHICLE USEFUL LIFE

ADR 111/00 continues the same previous durability requirement for emission control devices to function so that vehicles meet the emission limits over a target useful life of 160,000 km. However, the requirement now refers to the WLTP test in place of the previous NEDC procedure.

For gasoline vehicles, manufacturers can use assigned deterioration factors for each pollutant to account for the durability requirement instead of performing the mileage accumulation tests, which are known as aging tests. ADR 111/00 continues to use the same Euro 5 deterioration factors for gasoline vehicles but using deterioration factors for diesel vehicles is not allowed anymore. Therefore, diesel vehicles must undergo the applicable aging durability tests to establish deterioration factors and demonstrate durability.

The Australian emission standards continue to *not* require in-service conformity (ISC) or market surveillance checks, which are important enforcement measures in the European Union. The former Euro 5-equivalent regulation ADR 79/04 did not require

14 Activating an AES typically leads to increased emissions and is allowed only to avoid any sudden and irreparable damage to the combustion engine. Unauthorized use or activation of the AES constitutes a defeat device.

the ISC, either. ISC checks are performed in the European Union to verify compliance of in-use vehicles for a period of up to 100,000 km or 5 years, whichever is sooner.

The Euro 7 standard extends the durability requirements to 160,000 km or 8 years and introduces an "additional lifetime" requirement—with 20% less-stringent emission limits for gaseous pollutants—up to 200,000 km or 10 years. It also aligns the ISC check period with the durability requirements.

Additionally, new elements in Euro 7 are durability requirements for the energy storage capacity of batteries and for the achievable range of battery electric vehicles and PHEVs.

OTHER REQUIREMENTS

Following the former ADR 79/04 standard, the new Australian regulations set limits for CO emissions for tests at idling speed, crankcase gas emissions, and cold-start exhaust CO and HC emissions at low ambient temperature. These tests requirements apply for gasoline vehicles only.

Euro 7 goes beyond setting type-approval emission requirements on a vehicle level by extending the scope to particle emissions of brake systems and tires.

EXPECTED HEALTH BENEFITS

Australia's regulatory impact analyses estimated that the new emission standards will lead to total benefits of more than AU$6.3 billion accrued over the period 2026–2040, which is more than 4 times higher than the estimated total costs of compliance.[15] The key benefits of the standards include about AU$4.6 billion in avoided health costs and AU$1.5 billion in fuel cost savings through 2040.

This package of Euro 6d-equivalent standards, combined with the improved fuel quality standards to be implemented between 2025 and 2028, is estimated to result in slightly larger benefits than for the emission standards alone—about AU$6.4 billion in total benefits by 2040. That outweighs the associated costs of compliance, approximately AU$1.8 billion, by a factor of almost 3.6.

15 Australian Government, "Improving Australia's Fuel and Vehicle Emissions Standards."

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