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Electrically propelled road vehicles – Measurement of emissions of hybrid vehicles – Part 1: Thermal electric hybrid vehicles

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Eldrivna vägfordon – Mätning av emissioner från hybridfordon – Del 1: Termoelektriska hybridfordon

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Electrically propelled road vehicles - Measurement of emissions of hybrid vehicles - Part 1: Thermal electric hybrid vehicles

Véhicules routiers à propulsion électrique - Mesurage des
émissions des véhicules hybrides - Partie 1: Véhicules
hybrides électriques thermiques

Elektrisch angetriebene Straßenfahrzeuge - Messung der
Emissionen von Hybridfahrzeugen - Teil 1: Thermische
Hybrid-Elektrofahrzeuge

This European Standard was approved by CEN on 8 March 2001.

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 301 "Electrically propelled road vehicles", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2001, and conflicting national standards shall be withdrawn at the latest by October 2001.

CEN TC 301 is dealing with "Electrically propelled road vehicles". This title includes, in fact a wide range of electric road vehicles (see the definitions in EN 13447:2001) which can be divided as follows:

- Pure electric vehicle : this is an electrically propelled and infrastructure independent exclusively electrically supplied road vehicle.
- Road vehicle fitted with an electric transmission : this vehicle remains in the scope of CEN/TC 301 but is considered as a conventional (e.g. an internal combustion engine vehicle) vehicle with a specific transmission (no standards to be developed).
- Thermal electric hybrid vehicles where the thermal engine has such a low level of power ¹⁾ compared to that of the power train power may be treated as a pure electric vehicle from the measuring point of view.
- Other infrastructure independent electric vehicles which are today called electric hybrid vehicles. These electric hybrid vehicles can run with a zero level pollutant emission.
- Infrastructure dependent electrically propelled road vehicles are excluded from application of this standard.

A large amount of work has been undertaken on electric hybrid vehicles, and there is still a lot to discover on these vehicles which can for instance incorporate several driving modes (more than two).

To remain today within what is most common, the term thermal electric hybrid vehicle will be understood as an electric road vehicle fitted with a thermal machine (which is fed with fuel).

This European Standard EN 13444 consists of the following parts, under the general title "Electrically propelled road vehicles - Measurement of emissions of hybrid vehicles":

- Part 1: Thermal electric hybrid vehicles ;
- Part 2: Other hybrid vehicles than those fitted with a thermal machine.

Annex A forms an integral part of EN 13444-1.

Annex B to Annex D are for information only.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

¹⁾ In order to be able to use existing measuring facilities.

1 Scope

This standard aims at defining the emission measurements for a thermal electric hybrid road vehicle from M₁, N₁, or M₂²⁾ category, and for tricycles and quadricycles from the motorcycle types³⁾.

This standard applies to the above mentioned vehicles whose emission can be tested following the provisions already laid down for conventional vehicles (i.e. Internal Combustion engine vehicle) from the equivalent categories.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13447:2001,	Electrically propelled road vehicles - Terminology
EN 1986-2:2001,	Electrically propelled road vehicles - Measurement of the energy performances - Part 2 : Thermal electric hybrid vehicles
EN ISO 3675,	Crude petroleum and liquid petroleum products – Laboratory determination of density - Hydrometer method (ISO 3675:1998)

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply (see also EN 13447:2001).

3.1 electrically propelled road vehicle
road vehicle in which electric energy is transformed by electrical machine(s) into mechanical energy for traction purpose.

NOTE Traction is the term used with the same meaning as propulsion, but for historical reasons, this is the most widely used term.

3.2 electric hybrid (road) vehicle
hybrid (road) vehicle in which one of the reversible energy source produces electric energy.

3.3 thermal electric hybrid vehicle
electric hybrid vehicle in which the traction system contains a thermal machine.

NOTE Vehicle integrating electric machine(s) for functional assistance to the engine such as load levelling devices, starter, electrically driven auxiliary units, etc. should not be considered as electric hybrid vehicles, in so far they do not participate to the traction.

3.4 pure electric mode
driving mode when only the secondary on board electric energy source delivers energy for traction purpose. The pure electric mode can be either selected by the driver or automatically selected by the system.

For definitions of primary or secondary on board electric energy source, refer to EN 13447:2001 (Terminology).

²⁾ Categories of vehicle M1, N1, and M2 are defined in Directive 92/53/EEC.

³⁾ Motor tricycles and quadricycles are defined in Directive 92/61/EEC. In practice, tricycles and quadricycles with a maximum speed over 45 km/h fall within the scope of this standard.

3.5

pure thermal mode

for a thermal electric hybrid vehicle is the driving mode which can be selected by the driver when only the additional other kind of on board energy source (including the thermal machine) participates in the propulsion of the vehicle. In this case, the on board secondary electric energy source is not active even for energy recovery.

3.6

hybrid mode (for an electric hybrid vehicle)

another driving mode than the pure electric mode if selected by the driver, or the pure thermal mode. All the on board energy sources can participate in the propulsion of the vehicle, in accordance with the management system logic. The hybrid mode includes the pure electric mode when it is automatically selected by the system.

3.7

series electric hybrid vehicle

series hybrid vehicle in which all energy sources deliver electric energy.

3.8

parallel electric hybrid vehicle

electric hybrid vehicle for which the wheel propulsion is produced either by the electric drive train and/or by the additional form of on board energy source delivering mechanical power, both through a transmission which can be common or individual

3.9

on board energy source

subsystem of the traction system consisting of a combination of at least storage(s) and possibly converter(s), transmission(s), ancillary device(s). The on-board energy source delivers energy to the power train for traction purpose.

EXAMPLE 1

For a pure electric vehicle, the on board energy source can be made of:

- for the storage : an electrochemical storage battery ;
- for the energy delivery system : cables ;
- for the ancillary devices : thermal management of the battery, on board charger, protection devices.

EXAMPLE 2

For a series thermal electric hybrid vehicle, the additional other kind of on board energy source can be made of:

- for the storage : a petrol tank,
- for the energy delivery system : a generating set including an IC engine plus an alternator and a rectifier,
- for the ancillary devices : electronic controllers and a cooling system.

4 Measurement of the emissions in hybrid mode

4.1 Principle

The exhaust emission measurement results follow the same test procedure as for the consumption measurement results, i.e. same vehicle conditions (including driving mode), and same speed profile.

If a pure thermal mode can be selected by the driver, the test of the emission in hybrid mode shall be performed in pure thermal mode following strictly Directive 70/220/EEC as amended ⁴⁾. Then, the thermal electric hybrid vehicle behaves like a thermal engine vehicle, and no test procedure in hybrid mode is required.

Otherwise, the whole test procedure has to be fulfilled in hybrid mode (see 4.7).

The following test procedure ensures that the additional other form of on board energy source participates to the propulsion of the vehicle. This is the reason why the total distance travelled shall exceed the range of the vehicle in pure electric mode (see clause 4 in EN 1986-2:2001), thus implying at least one cold start of the thermal engine.

Annex A completes the operation mode, and defines the measurements to perform and the calculations.

4.2 Cycle

The cycle is the same as that described in 6.2 in EN 1986-2:2001.

4.3 Equipment

The equipments are the same as those described in 6.3 in EN 1986-2:2001.

4.4 Fuel

The fuel is the same as that described in 6.4 in EN 1986-2:2001.

4.5 Parameters, units and accuracy of measurements

They are the same as those described in Table 1 in EN 1986-2:2001 with the following additions:

Table 1

Parameter	Units	Accuracy	Precision
Nitrogen oxide	vol ppm ¹⁾	2 %	1 vol ppm ¹⁾
Particulates (for compression ignition engine only)	µg	± 5 µg	1 µg
¹⁾ Vol ppm means parts per million in volume.			

4.6 Test conditions

The test conditions are the same as described in 6.6 in EN 1986-2:2001.

4.7 Operation mode

The operation mode is that described in 6.7 in EN 1986-2:2001, but replacing the set "hydrocarbon, carbon monoxide and carbon dioxide" with the following set "hydrocarbon, nitrogen oxide, carbon monoxide and particulates". Additionally the Annex A proposed in EN 1986-2:2001 is to be replaced by the Annex A of this European standard, and Annex D by Annex C.

Furthermore, it is recommended to measure the emissions only when the thermal engine is on.

4.8 Expression of the results

The emission noted in the test report are the following :

⁴⁾ At the time of the elaboration of this standard, Directive 70/220/EEC was last amended by Directive 96/69/EC. In case of further amendments, a check of their compatibility with this standard should be undertaken.

- HC as the hydrocarbon emission expressed in grams per kilometre ;
- CO as the carbon monoxide emission expressed in grams per kilometre ;
- NO_x as the nitrogen oxides expressed in grams per kilometre ;
- particulate (for compression ignition engine only), expressed in grams per kilometre.

These values are rounded to the nearest hundredth of grams per kilometre.

Test results may be given as in Annex D.

Annex A (normative)

Measurement of the emissions

A.1 General

A.1.1 The measurement of emissions is based on the procedures as described in Directive 70/220/EEC as amended ⁵⁾ i.e. drive according to the test cycle and measure exhaust emissions.

A.1.2 The emission results are, for each of the following, the pollutants emitted during the test, divided by the total distance travelled during the test :

- carbon monoxide (CO) ;
- hydrocarbons (HC) ;
- nitrogen oxides (NO_x) ;
- particulates (for compression ignition engine only).

A.1.3 The mass *m* of each gaseous emission emitted by the vehicle during the test is determined by obtaining the product of the volumetric concentration and the volume of the gas in question, with due regard to the following densities under the reference conditions (see A.3).

- in the case of carbon monoxide (CO) : $Q_{CO} = 1,25 \text{ g/l}$;
- in the case of hydrocarbons (CH_{1,85}) : $Q_{CH} = 0,619 \text{ g/l}$;
- in the case of nitrogen oxides (NO_x) : $Q_{NO_x} = 2,05 \text{ g/l}$.

The mass *m* of particulates emissions (expressed in grams) from the vehicle during the test is defined by weighing the mass of particulates collected by the two filters, *m*₁ by the first filter, *m*₂ by the second filter.

- if $0,95 (m_1 + m_2) \leq m_1$, $m = m_1$;
- if $0,95 (m_1 + m_2) > m_1$, $m = m_1 + m_2$;
- if $m_2 > m_1$, the test is cancelled.

A.2 Recorded values

The recorded values during the test are the following:

- total travelled distance *d*, expressed in metres ;
- test duration *t*, expressed in seconds ;
- volumetric concentration of carbon monoxide, expressed in vol ppm ⁶⁾ ;

⁵⁾ At the time of the elaboration of this standard, Directive 70/220/EEC was last amended by Directive 96/69/EC. In case of further amendments, a check of their compatibility with this standard shall be undertaken.

- volumetric concentration of carbon dioxide, expressed in vol % ⁷⁾ ;
- volumetric concentration of hydrocarbon, expressed in vol ppm ⁶⁾ ;
- volumetric concentration of nitrogen oxides, expressed in vol ppm ⁶⁾ ;
- mass of particulates (for compression ignition engine only), expressed in grams ;
- volume of diluted exhaust gas for the Constant Volume Sampler (CVS) with gas storage method (expressed in litres per test) or gas flow for the Continuous Analysis Method (CAM) (expressed in litres per second) ;
- ambient temperature, expressed in kelvins ;
- relative ambient humidity, expressed in percentage ;
- atmospheric pressure, expressed in kilopascals.

A.3 Calculation

There are two methods for the calculation of pollutant emissions.

A.3.1 CVS with gas storage method

The exhaust gas sampling system shall be able to measure the actual quantities of emissions in the exhaust gases to be measured. The system to be used is the constant volume sampler system. This requires that the vehicle exhaust be continuously diluted with ambient air under controlled conditions. In the constant volume sampler concept of measuring, two conditions shall be satisfied : the total volume of the mixture of exhaust gases and dilution air shall be measured and a continuously proportional sample of the volume shall be collected for analysis.

For a thermal electric hybrid vehicle fitted with a gasoline engine, the quantities of emissions are determined from the sample concentrations, corrected for the content of the ambient air and the totalled flow over the test period.

For a thermal electric hybrid vehicle fitted with a diesel engine, the quantities of CO and NO_x emitted are determined with the same way as for a thermal electric hybrid vehicle fitted with a gasoline engine. The quantities of HC emitted are calculated from the integration of HC continuous analysis (see A.3.3).

The particulate emission level is determined by using suitable filters to collect the particulates from a proportional part flow throughout the test and determining the quantity thereof gravimetrically.

6) Vol ppm means parts per million in volume.

7) Vol % means parts per cent in volume.