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Hybrid-electric road vehicles — Exhaust emissions and fuel consumption measurements —

Part 1: Non-externally chargeable vehicles

Véhicules routiers électriques hybrides — Mesurages des émissions à l'échappement et de la consommation de carburant —
Partie 1: Véhicules non rechargeables par des moyens externes

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 37, *Electrically propelled vehicles*.

This second edition cancels and replaces the first edition (ISO 23274-1:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the content of ISO/TR 11955:2008, *Hybrid-electric road vehicles —Guidelines for charge balance measurement* was merged with this document as Annex D.

A list of all parts in the ISO 23274 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Hybrid-electric road vehicles — Exhaust emissions and fuel consumption measurements —

Part 1: Non-externally chargeable vehicles

1 Scope

This document specifies a chassis dynamometer test procedure to measure the exhaust emissions and the electric energy and fuel consumption for the vehicles.

This document applies to vehicles with the following characteristics:

— vehicles classified as passenger cars or light duty trucks, as defined in the relevant regional applicable driving test (ADT) standard;

— the nominal energy of the rechargeable energy storage system (RESS) is at least 2 % of the total energy consumption over an ADT;

— internal combustion engine (ICE) only using liquid fuels (for example, gasoline and diesel fuel).

NOTE In the case of the vehicles with ICE using other fuel [for example, compressed natural gas (CNG), liquefied petroleum gas (LPG), hydrogen], this document can apply except the measurement of consumed fuel; otherwise the measurement method for those using the corresponding fuel can apply.

This document proposes procedures for correcting the measured emissions and fuel consumption of hybrid-electric vehicles (HEVs), in order to obtain the values when the state of charge (SOC) of the RESS does not remain the same between the beginning and the end of an ADT.

It can also be applied to measurement procedures for exhaust emissions and fuel consumption of externally chargeable HEVs when a vehicle is not externally charged and operated only in the charge sustaining (CS) state, as described in ISO 23274-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10521 (all parts), *Road vehicles — Road load*

ISO/TR 8713, *Electrically propelled road vehicles — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
applicable driving test
ADT
single driving test schedule which is specified for a relevant region

Note 1 to entry: Chassis dynamometer test schedules for a relevant region are the Worldwide Light-duty Test Cycle (WLTC) or the Urban Dynamometer Driving Schedule (UDDS), for example.

3.2
charge balance of RESS
change of charge in the *RESS* (3.10) during fuel consumption measurement

Note 1 to entry: Normally expressed in ampere hours (Ah).

3.3
coulomb efficiency
Ah efficiency
efficiency of the battery, based on electricity in coulomb for a specified charge/discharge procedure, expressed by output electricity divided by input electricity

3.4
energy balance of RESS
ΔE_{RESS}
change of *RESS* (3.10) energy state during an *applicable driving test* (3.1)

Note 1 to entry: Normally expressed in watt hours (Wh).

Note 2 to entry: For practical use, the energy balance of RESS is approximated by multiplying the *charge balance of RESS* (3.2) in ampere hours (Ah) by the nominal voltage in volts (V).

3.5
energy efficiency
Wh efficiency
efficiency of the battery, based on energy for a specified charge/discharge procedure, expressed by output energy divided by input energy

3.6
externally chargeable HEV
HEV (3.7) with a *RESS* (3.10) that is intended to be charged from an external electric energy source

Note 1 to entry: External charge for the purpose of conditioning of the RESS is not included.

Note 2 to entry: Externally chargeable HEVs are widely known as plug-in HEVs (PHEVs).

3.7
hybrid-electric vehicle
HEV
vehicle with both a *RESS* (3.10) and a fuelled power source for propulsion

EXAMPLE Internal combustion engine or fuel cell systems are typical types of fuelled power sources.

3.8
non-externally chargeable HEV
HEV (3.7) with a *RESS* (3.10) that is not intended to be charged from an external electric energy source

3.9
rated capacity
supplier's specification of the total number of ampere hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions such as discharge rate, temperature and discharge cut-off voltage

3.10
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the electric drive

EXAMPLE Batteries or capacitors.

3.11
regenerative braking
braking with conversion of kinetic energy into electric energy for charging the *RESS* (3.10)

3.12
state of charge
SOC
available capacity of a *RESS* (3.10) or RESS subsystem expressed as a percentage of *rated capacity* (3.9)

4 Test conditions and instrumentation

4.1 Test conditions

4.1.1 General

For test conditions, 4.1.2 to 4.1.4 apply. Otherwise, the test conditions of the relevant regional ADT standards apply.

4.1.2 Ambient temperature

Tests shall be conducted at ambient temperature of (25 ± 5) °C.

4.1.3 Vehicle conditions

4.1.3.1 Vehicle conditioning

Prior to testing, the test vehicle with RESS shall be stabilized as specified by the manufacturers, or the mileage shall be accumulated to above 3 000 km and less than 15 000 km.

4.1.3.2 Vehicle appendages

Vehicles shall be tested with normal appendages (mirrors, bumpers, etc.). When the vehicle is on the dynamometer, certain items (e.g. hub caps) should be removed for safety reasons, where necessary.

4.1.3.3 Vehicle test mass

The vehicle test mass shall be selected in accordance with the relevant regional ADT standards.

4.1.3.4 Tyres

4.1.3.4.1 General

The correctly rated tyres as recommended by the vehicle manufacturer shall be used.

4.1.3.4.2 Tyre pressure

The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer in accordance with the test chosen (track or chassis dynamometer).

4.1.3.4.3 Tyre conditioning

The tyres shall be conditioned as recommended by the vehicle manufacturer.

4.1.3.5 Lubricants

The vehicle lubricants normally specified by the manufacturer shall be used.

4.1.3.6 Gear shifting

If the vehicle is fitted with a manually shifted gear box, gear shifting positions shall correspond to the relevant regional ADT standard. However, the shift positions should be selected and determined in accordance with the vehicle manufacturer's specification.

4.1.3.7 Regenerative braking

If the vehicle has regenerative braking, the regenerative braking system shall be enabled for all dynamometer testing except where specified in 4.1.4.4 determining the dynamometer load coefficient.

If the vehicle is tested on a single axle dynamometer and is equipped with systems such as an antilock braking system (ABS) or a traction control system (TCS), those systems may inadvertently interpret the non-movement of the set of wheels that are off the dynamometer as a malfunctioning system. If so, these systems shall be temporarily disabled for adjustment to achieve normal operation of the remaining vehicle systems, including the regenerative braking system.

4.1.3.8 RESS conditioning

The RESS shall be conditioned with the vehicle as specified in 4.1.3.1, or by equivalent conditioning.

4.1.4 Chassis dynamometer conditions

4.1.4.1 General

The vehicle should generally be tested on a single axle chassis dynamometer. A vehicle with four-wheel drive shall be tested by modifying the drive train of the vehicle. When the vehicle is modified, the details shall be explained in the test report.

Double axle chassis dynamometer testing should be performed if a modification for single axle chassis dynamometer testing is not possible for a specific four-wheel drive vehicle.

4.1.4.2 Dynamometer calibration

The dynamometer shall be calibrated in accordance with the specifications indicated in the service manual provided by the dynamometer manufacturers.

4.1.4.3 Dynamometer warm-up

The dynamometer shall be warmed up sufficiently prior to testing.

4.1.4.4 Determining the dynamometer load coefficient

The determination of vehicle road load and the reproduction on a chassis dynamometer shall conform to the ISO 10521 series Vehicles equipped with regenerative braking systems that are activated at least in part when the brake pedal is not depressed shall have regenerative braking disabled during the deceleration portion of coast-down testing on both the test track and dynamometer.

4.2 Test instrumentation

Test instrumentation shall have accuracy levels as shown in Table 1, unless specified differently by the relevant regional ADT standards.

Table 1 — Accuracy of measured values

Item	Unit	Accuracy
Time	s	±0,1 s
Distance	m	±0,1 %
Temperature	°C	±1 °C
Speed	km/h	±1 %
Mass	kg	±0,5 %
Current	A	±0,5 %[a]
Capacitor voltage	V	±0,5 %
[a] Accuracy for measure value: ±0,5% full scale deflection or ±1% of reading, whichever is greater.		

5 Measurement of exhaust emissions and fuel consumption

5.1 General

The ADT procedure shall be selected according to the relevant regional ADT standards. Common requirements, if not described in the relevant regional ADT standards, are described below.

5.2 Test procedure

5.2.1 Vehicle preconditioning

Vehicle preconditioning shall be carried out in accordance with the relevant regional ADT standard, if necessary.

If necessary, the RESS SOC may be preadjusted by charging or discharging, to obtain a suitable energy balance of RESS between the beginning and the end of the test.

5.2.2 Vehicle soak

The vehicle shall be soaked in accordance with the relevant regional ADT standards.

5.2.3 Vehicle movement to the test room

When the vehicle is brought into the test room, and moved during the test if necessary, it shall be pushed or towed (neither driven nor regenerative recharged). The test vehicle shall be set on the chassis dynamometer after the chassis dynamometer has warmed up just before the test. The vehicle shall not be activated during soak until right before starting the test.

5.2.4 Measurement over ADT

Energy balance of RESS, consumed fuel and exhaust emissions shall be measured in each ADT. The conditions of the vehicle during the ADT shall follow the relevant regional ADT standards.

5.3 Correction of the test results

5.3.1 General

Measured fuel consumption and exhaust emissions shall be corrected if these test results are influenced by RESS energy balance during the test. However, the correction is not necessary if the RESS energy balance satisfies the conditions in 5.3.2. The guidelines for charge balance measurement are described in Annex D.

5.3.2 Allowable range of RESS energy balance

The correction is not necessary if RESS energy balance is within the following range [see Formula (1)]:

$$|\Delta E_{\mathrm{RESS}}| \leq 0{,}01 \times E_{\mathrm{CF}} \tag{1}$$

where

ΔE_{RESS} is the energy change in RESS over the ADT in Wh;

E_{CF} is the energy of consumed fuel over the ADT in Wh.

Practical methods that apply to battery and capacitor are described in Annex B.

5.3.3 Correction procedure by correction coefficient

The vehicle manufacturer shall deliver the correction coefficient to calculate the fuel consumption and the exhaust emission at $\Delta E_{\mathrm{RESS}} = 0$. The correction coefficient can be obtained in accordance with Annex A. When the measured value is independent of ΔE_{RESS}, a correction is not required. See also Annex C for theory of the linear regression method (in case of batteries).

6 Calculations and expressions

To calculate the resultant exhaust emission and fuel consumption for an ADT, the relevant regional standards should be taken into consideration.

Annex A
(informative)

Linear correction method using a correction coefficient

A.1 General

This annex describes the calculation procedure to determine the exhaust emissions and fuel consumption at $\Delta E_{RESS} = 0$.

A.2 Method for correcting the exhaust emissions and fuel consumption

A.2.1 Data required for correction coefficient

A.2.1.1 General

The exhaust emissions and fuel consumption test shall be repeated several times to determine the correction coefficient defined in A.2.1.2.1. See Figure A.1. The ΔE_{RESS} shall be measured during the test. The SOC and ΔE_{RESS} should be in the normal range specified by the vehicle manufacturer.