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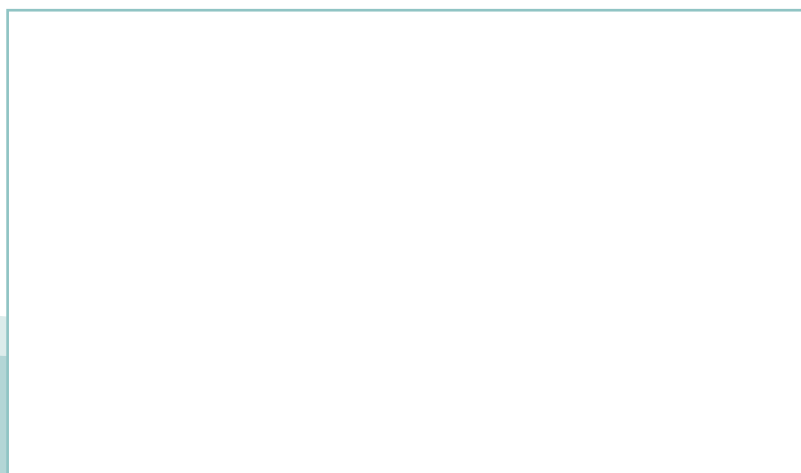
SS-ISO 23828:2014



Fastställt/Approved: 2014-02-21
Publicerad/Published: 2014-02-25
Utgåva/Edition: 2
Språk/Language: engelska/English
ICS: 43.120

**Vägfordon – Bränslecellsdrift – Mätning av energikonsumtion –
Fordon som använder komprimerad hydrogen
(ISO 23828:2013, IDT)**

**Fuel cell road vehicles – Energy consumption measurement –
Vehicles fuelled with compressed hydrogen
(ISO 23828:2013, IDT)**



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Den internationella standarden ISO 23828:2013 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 23828:2013.

Denna standard ersätter SS-ISO 23828:2008, utgåva 1.

The International Standard ISO 23828:2013 has the status of a Swedish Standard. This document contains the official version of ISO 23828:2013.

This standard supersedes the Swedish Standard SS-ISO 23828:2008, edition 1.

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Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för EI- och hybridfordon, SIS/TK 517.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 21, *Electrically propelled road vehicles*.

This second edition cancels and replaces the first edition (ISO 23828:2008), which has been technically revised.

Fuel cell road vehicles — Energy consumption measurement — Vehicles fuelled with compressed hydrogen

1 Scope

This International Standard specifies the procedures for measuring the energy consumption of fuel cell passenger cars and light-duty trucks that use compressed hydrogen and which are not externally chargeable.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 14687-2, *Hydrogen fuel — Product specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles*

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.

3.1

applicable driving test

ADT

single driving test schedule which is specified for each region

EXAMPLE Chassis dynamometer test cycle for light-duty vehicles in Japan (JC08), New European Driving Cycle (NEDC), Urban Dynamometer Driving Schedule (UDDS).

3.2

charge balance of battery

change of charge in battery during fuel consumption measurement

Note 1 to entry: Normally expressed in Ah.

3.3

energy balance of battery

ΔE_{RESS}

change of energy in battery during fuel consumption measurement

Note 1 to entry: Normally expressed in Wh.

Note 2 to entry: For practical use, the energy balance of a rechargeable energy storage system (RESS) is approximated by multiplying the charge balance of battery in Ah by the nominal voltage in V. "Nominal voltage" is defined in ISO 12405-1 or ISO 12405-2.

3.4

fuel cell hybrid electric vehicle

FCHEV

electrically propelled vehicle with a RESS and a fuel cell system as power sources for vehicle propulsion

**3.5
fuel cell vehicle
FCV**

electrically propelled vehicle with a fuel cell system as power source for vehicle propulsion

**3.6
pure fuel cell vehicle
pure FCV**

FCV with only a fuel cell system as power source for vehicle propulsion

**3.7
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, discharge cut-off voltage, etc.

**3.8
rechargeable energy storage system
RESS**

system that stores energy for delivery of electric power and which is rechargeable

EXAMPLE Batteries, capacitors.

**3.9
regenerative braking**

braking with conversion of kinetic energy into electric energy for charging the RESS

**3.10
state of charge
SOC**

available capacity in a battery pack or system expressed as a percentage of rated capacity

4 Measurement accuracy**4.1 General**

Measurement accuracy shall be in accordance with national standards.

4.2 Hydrogen measurement accuracy

Test apparatus shall ensure the accuracy of measurement of ± 1 % for the total mass of hydrogen consumption during the applicable driving test (ADT), unless otherwise specified in the relevant annexes.

5 Hydrogen consumption measurement**5.1 General**

Hydrogen consumption shall be measured using one of the following:

- pressure method;
- gravimetric method;
- flow method.

5.2 Pressure method

Hydrogen consumption is determined by measuring the pressure and temperature of gas in the hydrogen tank before and after the test. A tank with known internal volume that allows measurement of gas pressure and temperature shall be used for the test. Pressure method shall be performed in accordance with [Annex D](#).

5.3 Gravimetric method

Hydrogen consumption is calculated by measuring the mass of the hydrogen tank before and after the test. Gravimetric method shall be performed in accordance with [Annex E](#).

5.4 Flow method

The amount of hydrogen supplied to a vehicle is measured by a flowmeter. Flow method shall be performed in accordance with [Annex F](#).

6 Test conditions and instrumentation

6.1 Test conditions

6.1.1 General

For test conditions, the following applies unless otherwise specified in the regional standards or regulations (see [Annex A](#), [B](#), or [C](#), for example).

6.1.2 Ambient temperature

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

6.1.3 Vehicle conditions

6.1.3.1 Vehicle conditioning

Prior to testing, the test vehicle shall be stabilized; this includes vehicle mileage accumulation in accordance with a manufacturer-determined distance, unless otherwise specified in [Annex A](#), [B](#), or [C](#).

6.1.3.2 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 reasons of safety, where necessary.

6.1.3.3 Vehicle test mass

The vehicle test mass shall be selected according to the regional standards and/or regulations (see [Annex A](#), [B](#), or [C](#), for example).

6.1.3.4 Tyres

6.1.3.4.1 General

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

6.1.3.4.2 Tyre pressure

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

6.1.3.4.3 Tyre conditioning

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

6.1.3.5 Lubricants

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

6.1.3.6 Gear shifting

If the vehicle is fitted with a manually shifted gear box, gear shifting positions shall correspond to the regional test procedure (see [Annex A, B](#), or [C](#), for example). However, the shift positions should be selected and determined in accordance with the vehicle manufacturer's specification.

6.1.3.7 Regenerative braking

If the vehicle has regenerative braking, the regenerative braking system shall be enabled for all dynamometer testing except where specified in [6.1.4.4](#) chassis dynamometer conditions.

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 can 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.

6.1.3.8 RESS conditioning

The RESS shall be conditioned with the vehicle as specified in [6.1.3.1](#) or by equivalent conditioning.

6.1.3.9 Test fuel

ISO 14687-2 and the equivalent regional standards shall apply to test fuel.

6.1.4 Chassis dynamometer conditions

6.1.4.1 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.

6.1.4.2 Dynamometer calibration

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

6.1.4.3 Dynamometer warm-up

The dynamometer shall be warmed up sufficiently prior to testing.

6.1.4.4 Determining the dynamometer load coefficient

The determination of vehicle road load and the reproduction on a chassis dynamometer shall conform to ISO 10521. 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.

6.2 Test instrumentation

Test instrumentation shall have accuracy levels as shown in [Table 1](#), unless specified differently in [Annex A](#), [B](#), or C.

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 %
Capacitor voltage	V	±0,5 % of nominal voltage

6.3 Fuel consumption tests

6.3.1 General

Depending on the region concerned, the appropriate procedure shall be followed from [Annex A](#), [B](#), or C. Details and common procedures for each test mode are described below.

6.3.2 Vehicle preconditioning

Vehicle preconditioning shall be carried out in accordance with the annex appropriate for the region. In the case of FCHEV, the RESS state of charge can be pre-adjusted by charging or discharging, to obtain a suitable energy difference in RESS between the start and the end of test.

6.3.3 Vehicle soak

The vehicle shall be soaked in accordance with the appropriate regional procedure prescribed in [Annex A](#), [B](#), or C.

6.3.4 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.

6.4 Measurement and calculation over applicable driving test (ADT)

For the measurement of hydrogen consumption, the test vehicle shall be driven on the chassis dynamometer in accordance with the ADT prescribed for the region (see [Annex A](#), [B](#), or C). The hydrogen consumption shall be measured by one of the methods described in [Annex D](#), [E](#), or F or by an alternative method that provides equivalent accuracy.