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Agricultural tractors — Test procedures —
Part 9: Power tests for drawbar

прийнято як національний стандарт
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Методики випробування.
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2018-02

Agricultural tractors — Test procedures —

Part 9: Power tests for drawbar

Tracteurs agricoles — Méthodes d'essai —

Partie 9: Essais de puissance à la barre d'attelage

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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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

This second edition cancels and replaces the first edition (789-9:1990), which has been technically revised for the technical harmonization with OECD Code 2: February 2017. It also incorporates the Amendment ISO 789-9:1990/Amd.1:1993.

A list of all the parts in the ISO 789 series can be found on the ISO website.

Agricultural tractors — Test procedures —

Part 9: Power tests for drawbar

1 Scope

This document specifies test procedures for determining the power available at the drawbar on agricultural tractors of the wheeled, track-laying or semi-track-laying type.

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 789-13:2018, *Agricultural tractors — Test procedures — Part 13: Vocabulary and specimen test report*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 789-13 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/

4 Measurement units and tolerances

The following units and tolerances apply to the maximum value measured:

— rotational frequency, in revolutions per minute (r/min): ± 0,5 %;

— time, in seconds (s): ± 0,2 s;

— distance, in metres or millimetres (m or mm): ± 0,5 %;

— force, in newtons (N): ± 1 %;

— mass, in kilograms (kg): ± 0,5 %;

— fuel consumption, in kilograms per kilowatt hour (kg/kWh): ± 1 %;

— atmospheric pressure, in kilopascals (kPa): ± 0,2 kPa;

— tyre pressure (gauge), in kilopascals (kPa): ± 5 %;

— temperature of fuels, etc., in degrees Celsius: ± 2 °C;

— wet and dry bulb thermometer temperature, in degrees Celsius: ± 0,5 °C.

5 General requirements

5.1 Selection

In the case of a third party performing the assessment, the tractor manufacturer and the third party shall work together to select a tractor to be submitted for testing. The tractor submitted for the test shall require a serial number, shall comply with the manufacturer's product specification, and shall be operated in accordance with the manufacturer's instructions. The manufacturer shall provide a representative to be present throughout the entire testing of the tractor.

5.2 Running-in and preliminary adjustments

5.2.1 The tractor shall be new and run-in prior to the test in accordance with the manufacturer's usual instructions. If a third party is responsible for the testing, the third party itself may run-in the tractor provided an authority of the manufacturer or the manufacturer's representative, who will remain responsible for the running-in, is obtained.

The test report shall state the place and duration of running in.

5.2.2 The adjustment of the carburettor or injection pump as well as the setting of the governor shall conform to the specifications provided by the manufacturer. The manufacturer may make adjustments in conformity with these specifications prior to testing, but adjustments shall not be made during the test.

5.3 Manufacturer's instructions

Once the test has started, the tractor shall never be operated in a way that is not in accordance with the manufacturer's published instructions in the form of an operating handbook unless specifically required by test criteria and then only by arrangement with the manufacturer.

5.4 Repairs

All repairs made during the tests shall be noted in the test report, together with comments on any practical defects or shortcomings about which there is no doubt.

5.5 Preliminary information

Specification information of the tractor consisting of the items listed in the ISO 789-13 specimen test report, as well as any further data required to carry out the tests, shall be recorded and used to set up the test.

These technical specifications shall be validated as thoroughly as possible by the entity performing the test.

5.6 Fuels and lubricants

5.6.1 Selection

Fuels and lubricants shall be selected from the range of products commercially available in the country where the equipment is tested, but shall conform to the minimum standards approved by the tractor manufacturer. If the fuel or lubricant conforms to a national or international standard, it shall be mentioned and the standard stated.

5.6.2 Measuring consumption

Measurement of fuel consumption during drawbar testing is required.

The fuel measurement apparatus shall be arranged so the fuel pressure at the carburettor or the fuel injection pump is equivalent to that which exists when the tractor's fuel tank is half full. The fuel temperature shall be comparable to that which is found during full load operation for 2 h, when the fuel is taken from the tractor fuel tank.

5.6.3 Tractors equipped with diesel particulate filters

In the case of a tractor equipped with a diesel particulate filter, a regeneration of the diesel particulate filter may be performed before starting the drawbar test. If the tractor initiates a regeneration of the diesel particulate filter during the test, the current test should be suspended and the regeneration should be allowed to complete before continuing the test.

5.7 Auxiliary equipment

For all tests, accessories such as the hydraulic lift pump or air compressor may only be disconnected if it is allowed in the operator's manual and is practicable for the operator to do so as normal practice in work. The accessories shall be disconnected without using tools and in accordance with the operator's manual. If not, they shall remain connected and operate at minimum load.

If the tractor is equipped with devices that create variable parasitic power losses, such as a variable speed cooling fan, intermittent hydraulic or electrical demands, etc., the device shall not be disconnected or altered for test purposes. If it is practical for the operator to disconnect the device as outlined by the operator's manual, it may be disconnected for test purposes, in which case this shall be recorded in the test report.

Power variations during tests caused by these devices exceeding ± 5 % shall be recorded in the test report in terms of percent variation from the mean.

5.8 Ambient conditions

5.8.1 No corrections shall be made to the test results for the atmospheric conditions or other factors. Atmospheric pressure shall not be less than 96,6 kPa. If this is not possible because of conditions of altitude, a modified injection pump setting may have to be used, details of which will be included in the report.

5.8.2 The atmospheric temperature at the test track shall be 20 °C ± 15 °C.

5.9 Tractor conditions

5.9.1 Tyres

At the beginning of the drawbar tests, the height of the tyre or rubber track tread bars, measured at the centreline of the tyres or tracks, shall be at least 65 % of their height when new. This height shall be measured using the technique and equipment specified in Annex A.

Tests may be carried out on one or more sets of different sized tyres, and the additional results may be included in the test report. However, only one of the tests may be selected for inclusion in the compulsory section of the test report.

5.9.2 Ballast

Ballast that is commercially available and approved by the manufacturer for use in agriculture may be fitted on the tractor. If the tractor has pneumatic tyres, liquid ballast in the tyres may also be used. The overall static weight on each tyre (including liquid ballast in the tyres and a 75 kg weight representing the driver) as well as the inflation pressure shall be within the limits specified by the tyre manufacturer.

5.10 Slip

Slip is determined using Formula (1):

$$S = 100\frac{(N_1 - N_0)}{N_1} \quad (1)$$

where

S is the wheel or track slip, in per cent (%);

N_1 is the sum of the revolutions of a driving wheel or driving track pulley for a given distance with slip;

N_0 is the sum of the revolutions of a driving wheel or driving track pulley for the same distance without slip.

For track-laying tractors, the slip between the track and the driving pulley is included in this slip calculation.

5.11 Testing rules

5.11.1 The test shall be carried out on a clean, horizontal, and dry concrete or tarmacadam surface containing a minimum number of joints. The type of test track shall be clearly stated in the report.

5.11.2 During all tests, the throttle lever shall be set fully open unless specified otherwise.

5.11.3 Do not test in gears where the forward speed exceeds the safety limits of the test equipment.

5.11.4 The slip of the driving wheels or rubber tracks during testing shall not exceed 15 %. In the case of tractors having driving wheels or rubber tracks not mechanically linked together, the revolutions of each wheel or rubber tracks shall be separately recorded and the slip calculated for each wheel or rubber tracks. If the results for each wheel or rubber tracks differ by more than 5 %, they should be checked and separately reported. For track-laying tractors, the slip between the track and the driving pulley is included in the slip calculation given in 5.10.

5.11.5 The line of pull shall be horizontal. The drawbar may swing horizontally, but shall be parallel to the centre longitudinal plane of the tractor when collecting data. The vertical height of the drawbar shall be chosen per the manufacturer's specifications in such a way that the direction of the tractor can be controlled when it develops maximum drawbar pull.

To maintain steering capability during the test for tractors without rear axle steering, Formula (2) applies. It can be visualized in Figure 1.

$$PH \leq 0{,}8\ WZ \quad (2)$$

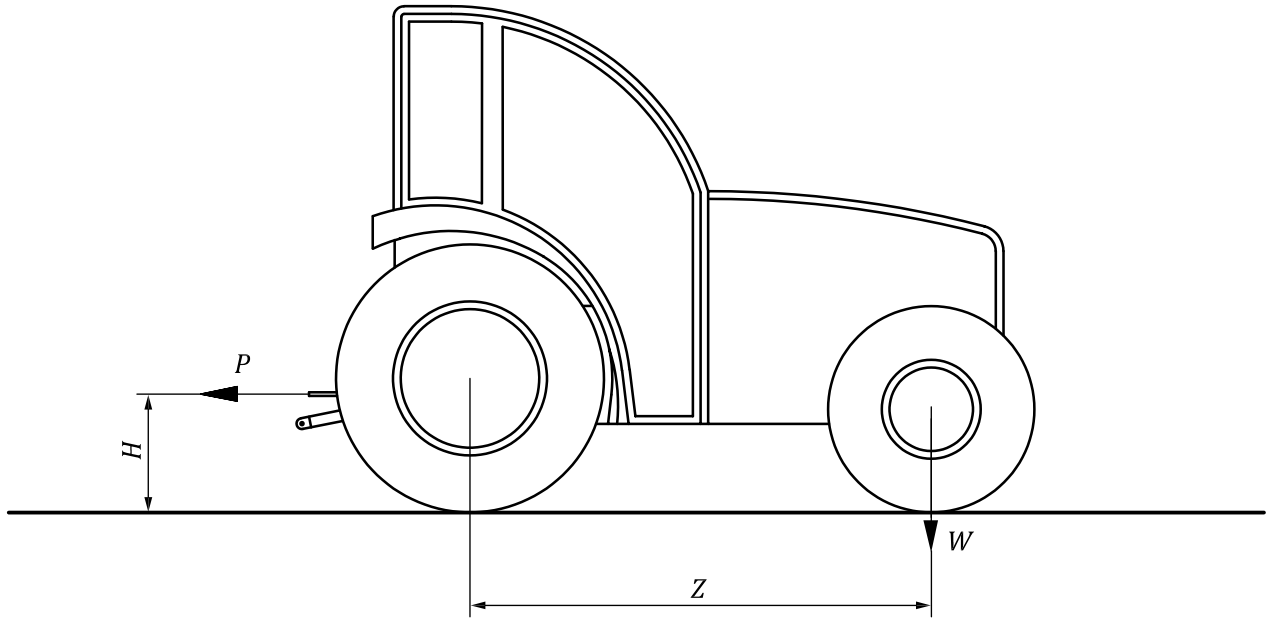
where

P is the maximum drawbar pull, in newtons;

H is the static height of the line of pull above the ground, in millimetres;

W is the static load exerted by the front wheels on the ground, in newtons;

Z is the wheelbase, in millimetres.



Key

P drawbar pull, in newtons

H static height of the line of pull above the ground, in millimetres

W static load exerted by the front wheels on the ground, in newtons

Z wheelbase, in millimetres

Figure 1 — Line of pull

5.12 Required measurements

For each gear or speed setting at the speed and pull giving maximum power in that gear/speed setting, the following items shall be reported in a format recommended in ISO 789-13:2018, Annex A:

— engine speed;

— power;

— drawbar pull;

— speed;

— slip of wheels or tracks;

— fuel consumption;

— temperature of fuel, coolant and lubricating oil;

— atmospheric conditions.

5.13 Warm-up

Prior to taking any measurements, the tractor shall be run for a sufficiently long warm-up period for power to become stabilized.

6 Test procedure

6.1 Maximum power

6.1.1 General

The maximum power tests will determine the power available at the drawbar of the unballasted tractor over a range of different gears/speed settings.

6.1.2 Geared transmissions

Measure the maximum drawbar power of the unballasted tractor over a range of gears. Record measurements starting in the gear giving a travel speed immediately slower than the gear at which maximum pull is produced, up to the gear giving a travel speed immediately faster than the gear at which the greatest maximum power is produced.

Any noticeable wheel hop should be noted in the report with corresponding slip values at which it occurred.

6.1.3 Continuously variable transmissions

In the case of tractors with continuously variable transmissions (CVTs), it may not be possible to record the maximum power in different gears with fixed gear ratios. Instead, measure and record the maximum drawbar power of the unballasted tractor at the speeds listed in Table 1.

Table 1 — CVT testing speeds

km/h	5	6	7,5	9	11	13	16

The speeds listed in Table 1 are required measuring points for tractors with CVTs; however, drawbar power output at additional forward speeds may be measured and reported at the discretion of the testing entity.

6.2 Fuel consumption

6.2.1 General

Fuel consumption shall be measured in two gears/speed settings typically used for fieldwork in order to provide information on operational efficiency at partial loads.

6.2.2 Nominal speed of 7,5 km/h

Measurements shall be made on an unballasted tractor in a gear/speed setting that delivers a nominal speed of 7,5 km/h, or a nominal speed nearest to that, at the following conditions:

a) maximum drawbar power available in the selected gear/speed setting at rated engine speed;

b) a pull equal to 75 % of the pull made in a) in the selected gear/speed setting;

c) a pull equal to 50 % of the pull made in a) in the selected gear/speed setting;

d) reduced engine speed in higher gears/speed settings (as chosen by the manufacturer) that are able to produce the same pull and travelling speed as in b);

e) reduced engine speed in the same gears/speed settings used in d) that are able to produce the same pull and travelling speed as in c).

6.2.3 Nominal speed between 7 and 10 km/h

Measurements shall be made on an unballasted tractor in a gear/speed setting, chosen by the manufacturer, which delivers a nominal speed between 7 km/h and 10 km/h. If such a gear/speed setting is not available, the nearest available gear/speed setting shall be chosen even though the speed may be less than 7 km/h or more than 10 km/h. Measurements shall be made at the following conditions:

a) maximum drawbar power available in the selected gear/speed setting at rated engine speed;

b) a pull equal to 75 % of the pull made in a) in the selected gear/speed setting;

c) a pull equal to 50 % of the pull made in a) in the selected gear/speed setting;

d) reduced engine speed in higher gears/speed settings (as chosen by the manufacturer) that are able to produce the same pull and travelling speed as in b);

e) reduced engine speed in the same gears/speed settings used in d) that are able to produce the same pull and travelling speed as in c).

6.2.4 Continuously variable transmissions

Some tractors with continuously variable transmissions may incorporate a control mode with automatic common engine speed and transmission control. All the tests in 6.2.2 and 6.2.3 shall first be performed in the most manual transmission mode offered by the tractor; afterwards, the tests may be repeated in the automatic mode.

In the case of a tractor with a continuously variable transmission, a transmission ratio or speed setting chosen for tests 6.2.2 d), 6.2.2 e), 6.2.3 d) and 6.2.3 e) shall be about 20 % higher than the selected speed setting.

6.2.5 Alternative tractor configuration

A second test series may optionally be performed on the tractor configured in a different manner, for example ballasted or with different tyres, in accordance with the manufacturer's specifications while following the exact instructions presented in 6.2.2 and 6.2.3. The number of such optional tests is not limited.

It is not necessary to record fuel consumption or to measure part loads when a full unballasted test has already been carried out.

6.3 Tractors without PTO capable of transmitting full engine power

6.3.1 General

In those cases when a tractor is not equipped with a power take-off, or when the power take-off is not permitted to transmit the full power of the engine, two additional drawbar tests under either unballasted or ballasted conditions shall be performed.

A gear/speed setting for these two tests shall be chosen by the manufacturer. The selected gear/speed setting shall be within the range of the lowest gear/speed setting that allows the maximum power of the engine to be utilized, to the highest gear/speed setting that allows a controllable test to be performed by the testing entity. The gear/speed setting selected shall allow the tests to be carried out down to a speed where maximum drawbar pull occurs at less than 15 % wheel or track slip.

6.3.2 Varying drawbar pull and speed at full load

A series of test runs shall be made in the selected gear/speed setting starting at maximum power at rated engine speed. The drawbar load shall then be stepwise increased resulting in a decrease of engine speed at approximately 100 min^{-1} (rev/min) speed increments. The test shall continue until either the drawbar pull reaches its maximum value or some other limiting condition specified by the manufacturer is reached.

6.3.3 Continuous one hour test at maximum power

A continuous one hour test shall be performed in the selected gear/speed setting at the engine speed where maximum power occurs (as determined in 6.2.2). Measurements shall be recorded at least every 10 min. The maximum drawbar power shall be the average of the readings made during the one-hour period. If the power deviates by more than ± 2 % from the average, the tests shall be repeated. If the variation continues, the deviation shall be stated in the report.

6.4 Statement of power rating

The power rating of the tractor is usually stated as PTO power (see ISO 789-1:2018, 6.5). If the tractor is not fitted with a PTO capable of transmitting the full power of the engine, the power rating of the tractor shall be stated as the power measured at the drawbar.

7 Test report

The test report shall include presentation of the following curves made for the full range of engine speeds available:

— gear number and range;

— drawbar power as a function of engine speed;

— drawbar pull as a function of engine speed;

— ground speed;

— fan speed;

— slip of wheels or tracks in reference to the ground;

— hourly and specific fuel consumption as a function of engine speed;

— specific fuel consumption as a function of power;

— hourly and specific reagent consumption as a function of engine speed (if applicable)

— temperature of fuel, coolant and lubricating oil;

— atmospheric conditions (temperature, relative humidity, and pressure).

In the following conditions, the drawbar power shall be reported in the recommended format of ISO 789-13:2018, Annex A:

a) maximum power over a range of different gears and speed settings;

b) maximum drawbar power at rated engine speed in the gear nearest 7,5 km/h;

c) drawbar power 75 % of the maximum drawbar pull at rated engine speed in the same gear that achieved maximum drawbar power;

d) drawbar power 50 % of the maximum drawbar pull at rated engine speed in the same gear that achieved maximum drawbar power;

e) drawbar power, in a higher gear than used for maximum drawbar power, that can maintain the same speed while producing 75 % of the maximum drawbar pull;

f) drawbar power the same gear as e) while producing 50 % of the maximum drawbar pull at the same speed as d);

g) maximum drawbar power at rated engine speed in the selected gear between 7 km/h and 10 km/h;

h) drawbar power 75 % of the maximum drawbar pull at rated engine speed in the same selected gear between 7 km/h and 10 km/h that achieved maximum drawbar power;

i) drawbar power 50 % of the maximum drawbar pull at rated engine speed in the same selected gear between 7 km/h and 10 km/h that achieved maximum drawbar power;

j) drawbar power, in a higher gear than the gear selected between 7 km/h and 10 km/h maximum drawbar power, that can maintain the same speed while producing 75 % of the maximum drawbar pull;

k) drawbar power the same gear as j) while producing 50 % of the maximum drawbar pull at the same speed as i);

l) for tractors without the ability to run full power through the PTO, a series of runs at increasing drawbar loads, at engine speed increments of min^{-1}, until the maximum value is reached;

m) for tractors without the ability to run full power through the PTO, the average of maximum drawbar power measurements taken over a one hour period the gear setting where the maximum power occurred in l).

Annex A
(normative)

Drawbar tests — Measurement of tyre tread and track

The height of the tyre or rubber track tread bars (see 5.9.1) shall be measured by use of a 3-point gauge. Each gauge leg shall terminate in a hemispherical tip of radius 5 mm. The gauge shall be placed astride the tread bar and perpendicular to the direction of the tread bar as close to the centreline of the tyre or rubber track as possible. Two legs of the gauge shall be positioned at the base of the tread bar (at the point of tangency between the tyre carcass and the radius joining the tread bar to the carcass). The third point of the gauge shall be in the centre of the tread bar.

The tread bar height shall be the difference in elevation between the two outside legs of the gauge and the centre point. The tread bar height measured in this manner shall be taken and averaged for a minimum of four equally spaced locations round the periphery of the tyre. It shall be compared to similar data on a new tyre of the same make, size type, and inflation pressure.

Bibliography

[1] ISO 789-1:2018, *Agricultural tractors — Test procedures — Part 1: Power tests for power take-off*

[2] OECD Code 2: February 2017. *OECD Standard Code for the official testing of agricultural and forestry tractor performance*

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