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Agricultural tractors — Test procedures —

Part 7:

Axle power determination

Tracteurs agricoles — Méthodes d'essai —

Partie 7: Détermination de la puissance aux roues motrices



Reference number
ISO 789-7:1991(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 789-7 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Sub-Committee SC 2, *Common tests*.

ISO 789 consists of the following parts, under the general title *Agricultural tractors — Test procedures*:

- Part 1: Power tests for power take-off
- Part 2: Rear three-point linkage lifting capacity
- Part 3: Turning and clearance diameters
- Part 4: Measurement of exhaust smoke
- Part 5: Partial power PTO — Non-mechanically transmitted power
- Part 6: Centre of gravity
- Part 7: Axle power determination
- Part 8: Engine air cleaner
- Part 9: Power tests for drawbar
- Part 10: Measurement of hydraulic power — Tractor/implement interface

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— *Part 11: Steering capability — Wheeled tractors*

Annex A forms an integral part of this part of ISO 789. Annexes B, C, D and E are for information only.

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Agricultural tractors — Test procedures —

Part 7:

Axle power determination

1 Scope

This International Standard specifies test procedures for determining the power available at the axle or axles of wheeled or track-laying agricultural tractors having one or two driven axles.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 789. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 789 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3448:1975, *Industrial liquid lubricants — ISO viscosity classification*.

ISO 4251-1:1988, *Tyres and rims (existing series) for agricultural tractors and machines — Part 1: Tyre designation and dimensions*.

3 Definitions

For the purposes of this part of ISO 789, the following definitions apply.

3.1 rated engine speed: Engine speed specified by the tractor manufacturer for continuous operation at full load.

3.2 axle power: Sum of the powers measured at all powered axles.

3.3 maximum permissible torque: Maximum torque specified by the manufacturer for the purposes of this test.

3.4 specific fuel consumption: Mass of fuel consumed per unit of work.

4 Measurement units and tolerances

The following units and tolerances are used in this part of ISO 789:

- a) rotational frequency, in revolutions per minute: $\pm 0,5 \%$
- b) time, in seconds: $\pm 0,2 \text{ s}$
- c) distance, in metres or millimetres: $\pm 0,5 \%$
- d) force, in newtons: $\pm 1 \%$
- e) torque, in newton metres: $\pm 1 \%$
- f) mass, in kilograms: $\pm 0,5 \%$
- g) fuel consumption, in kilograms per kilowatt hour: $\pm 1 \%$
- h) atmospheric pressure, in kilopascals: $\pm 0,2 \text{ kPa}$
- i) temperature of fuels, etc., in degrees Celsius: $\pm 2 \text{ }^{\circ}\text{C}$
- j) wet and dry bulb thermometers, in degrees Celsius: $\pm 0,5 \text{ }^{\circ}\text{C}$

5 General requirements

5.1 Specification

The tractor tested shall conform to the specification in the test report (see annex A) and shall be used in accordance with the manufacturer's recommendations for normal operation.

5.2 Running-in and preliminary adjustments

The tractor shall be run-in prior to the test. For spark-ignition engines fitted with a means for the operator to vary the ratio of the fuel/air mixture, the tests shall be carried out with the settings recommended for normal operation. The adjustment of the carburettor or the injection pump shall conform to the manufacturer's specification. Run-in shall be done with the governor set at full throttle and with the engine operating at rated speed.

5.3 Fuels and lubricants

The compression-ignition (diesel) fuel used for the test shall comply with the CEC reference fuel CEC-RF-03-A-84. For spark-ignition engines, the test shall be carried out using CEC reference fuel CEC-RF-01-A-80 for premium leaded gasoline and CEC RF-08-A-85 for premium unleaded gasoline. (See annex B, annex C and annex D, respectively.)

The lubricants used for the test shall comply with the manufacturer's specification and be identified by trade-name, type, and viscosity class in accordance with ISO 3448. If different lubricants are used, precise information shall be given as to where they are used (engine, transmission, etc.).

If the lubricant conforms to other national or International Standards, reference to these shall be made.

5.4 Ancillary equipment

For all tests, accessories such as the hydraulic lift pump or air compressor may only be disconnected if it is practicable for the operator to do so as normal practice in work, in accordance with the operator's manual and without using tools. 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: this shall be recorded in the test report.

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

5.5 Operating conditions

Make no corrections to the measured values of torque or power for 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 carburettor or fuel pump setting may have to be used, details of which shall be included in the report.

The surrounding temperature shall be $23\text{ }^{\circ}\text{C} \pm 7\text{ }^{\circ}\text{C}$.

Stable operating conditions shall have been attained at each load setting before beginning test measurements.

5.6 Fuel consumption

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

When consumption is measured by volume, calculate the mass of fuel per unit of work using the density corresponding to the appropriate fuel temperature. This figure shall then be used to calculate the volumetric data using the fuel density at $15\text{ }^{\circ}\text{C}$.

Alternatively, when the consumption is measured by mass, calculate volumetric data using the fuel density (specific gravity) value at $15\text{ }^{\circ}\text{C}$.

6 Test procedure

6.1 General

All the driven axles of the tractor shall be coupled to the dynamometer. All measurements shall be made with the engine governor control set for maximum engine speed.

The various tests shall normally be carried out continuously.

The angularity of any shaft connecting the driving axles to the dynamometer shall not exceed 2° .

If an exhaust gas discharge device for the test area is used, it shall not change the engine performance.

6.2 Choice of transmission ratios

Measurements shall be made in transmission ratios including and between that giving the slowest forward speed and that giving the fastest forward speed recommended by the manufacturer for field work, at between 3 km/h and 16 km/h. A minimum of six transmission ratios shall be used, their choice as far as possible allowing the efficiency of the various ratio-changing devices to be assessed.

If the tractor has a hydrokinetic torque converter which can be locked out by the driver, carry out the test both with the torque converter in operation and with it locked out.

If the tractor has a stepless variable transmission, carry out the test at six transmission ratios approximately equally spaced.

Tractors with two drive axles shall be tested with both axles engaged.

6.3 Control of speeds and torques

The torques applied and the rotational speeds of the two wheels of the same axle shall be equal. In the case of an axle which cannot be tested with the differential locked, the torques applied to each of the two wheels shall be controlled so that the deviation of the rotational speeds of the two wheels is less than 5 %.

In the case of tractors with two driven axles with a differential between them which cannot be locked, the torques applied to each of the two axles shall be controlled so that the deviation between the mean peripheral speeds of the front and rear wheels is less than 5 %. The dynamic radius indices of the tyres as defined in ISO 4251-1 shall be used for this determination.

In the case of tractors with two drive axles without a differential between them, power at the axles shall be measured with several distributions of power between them. For each transmission ratio selected, increase the torque on the axle for which the manufacturer indicates the higher permissible torque until the rated engine speed or the maximum torque permissible for the axle is reached. If the rated speed of the engine has not been reached, increase

the torque on the second axle until the rated engine speed or the maximum torque permissible for this second axle is reached. If the rated speed of the engine has still not been reached, the measurement shall be terminated for that transmission ratio.

If the rated speed of the engine is reached, the measurement shall be repeated as many times as necessary to obtain the maximum torque permissible at the second axle by reducing the torque applied to the first axle each time by 20 % of the value applied to that axle in the first measurement. If the maximum torque permissible for the second axle is reached, increase the torque on the first axle to attain rated engine speed.

For each measurement, record the rotational speed of each wheel, the torque applied to each wheel, the rotational speed of the engine and the fuel consumption. Also calculate the axle power.

6.4 Additional measurements

In addition to the performance measurements specified above, report the following:

- a) ambient air temperature at a representative point approximately 2 m in front of the tractor and approximately 1,5 m above the ground (where the tractor is fitted with a forward blowing pusher fan, ambient air temperature measurements shall be made at appropriate alternative positions);
- b) air temperature at the engine air intake;
- c) atmospheric pressure;
- d) relative air humidity;
- e) maximum coolant temperature (in case of an air-cooled engine, measure the temperature of the cylinder block at representative points);
- f) the fuel temperature at the inlet to the carburettor or injection pump;
- g) engine oil temperature;
- h) transmission oil temperature.

Annex A
(normative)

Specimen test report

A.1 Locations

Tractor manufacturer's name and address:
Place of running in:
Duration of running in:

A.2 Specification of tractor

Tractor

Model: Serial No.:

Engine

Make: Model:
Type: Serial No.:
Rated speed: min⁻¹

Cylinders

Number: Bore: mm
Stroke: mm Capacity: l

Fuel and injection system

Capacity of fuel tank: l
Make, type and model of injection pump:
Manufacturer's production setting: l/h
Make, type and model of injectors:
Make, type and model of magneto, coil and distributor:
Make, type and model of carburettor:
Injection or injection timing (manual or automatic):

Air cleaner

Make and model: Type:

Precleaner (if fitted)

Make and model: Type:

Transmission

Clutch

Type: Diameter of discs: mm

Nominal travel speeds

Gear						
Rear wheels Tyre size Dynamic radius index ¹⁾ Axle, r/min ²⁾ Nominal travel speed, km/h ²⁾						
Front wheels (if powered) Tyre size Dynamic radius index ¹⁾ Axle, r/min ²⁾ Nominal travel speed, km/h ²⁾						
1) See ISO 4251-1. 2) At rated engine speed.						

Steering
 Type:
 (for example, manual, power or power-assisted)
Wheels

Location of steered wheels:

Front
 Make of tyres: Type:
 (for example radial- or cross-ply)

Size:

Front axle powered (yes/no) Ply rating:

Dynamic radius index: mm

Rear
 Make of tyres: Type:
 (for example radial- or cross-ply)

Size:

Ply rating:

Wheelbase

..... mm

Track

Type: Number of track plates:

Width of track plates: mm

Masses (with tanks full but without driver)

Mass	Front	Rear	Total
Without ballast			
With ballast			

A.3 Fuel and lubricant specifications

Fuel

Trade-name: Octane (RON)¹⁾ :

Octane number or cetane No.: Density at 15 °C :

Type:

Engine oil

Trade-name: Type:

Viscosity class:

Transmission oil

Trade-name: Type:

Viscosity class:

Maximum temperatures

Coolant: °C

Engine oil: °C

Fuel: °C

Engine air intake: °C

Transmission oil: °C

1) RON: Research octane number

Table A.1 — Table of results[illegible]

Annex B

(informative)

Reference fuel CEC RF-01-A-80 for spark-ignition engines — Specifications — Premium gasoline leaded

Characteristic	Limits and units	Test method ¹⁾
Research octane number (RON)	98 min.	ISO 5164
Relative density 15 °C/4 °C (specific gravity)	0,748 ± 0,007	ISO 3675
Reid vapour pressure	60 kPa ± 4 kPa (600 mbar ± 40 mbar)	ISO 3007
Distillation		ISO 3405
Initial boiling point	32 °C ± 8 °C	
10 % (volume)	50 °C ± 8 °C	
50 % (volume)	100 °C ± 10 °C	
90 % (volume)	160 °C ± 10 °C	
Final boiling point	195 °C ± 10 °C	
Residue	2 % (V/V) max.	
Hydrocarbon analysis		ISO 3837
— Olefins	20 % (V/V) max.	
— Aromatics	45 % (V/V) max.	
— Saturates	balance	
Oxidation stability	480 minutes min.	ISO 7536
Existent gum	4 mg/100 mm ³ , max.	ISO 6246
Sulfur content	0,04 % (m/m) max.	ISO 4260, ISO 8754
Lead content	0,25 g/dm ³ ± 0,015 g/dm ³	ISO 3830
— Nature of scavenger	motor mix	
— Nature of lead alkyl	not specified	
Carbon/hydrogen ratio	to be reported	
NOTE — The blending of CEC RF-01-A-80 shall only use conventional European base materials, and exclude unconventional components such as pyrolysis gasoline, thermally cracked material and motor benzole.		
1) See annex E.		