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ISO 789-9

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AMENDMENT 1
1993-01-15

Agricultural tractors – Test procedures –

Part 9:
Power tests for drawbar

AMENDMENT 1

Tracteurs agricoles – Méthodes d'essai –

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

AMENDEMENT 1

Reference number
ISO 789-9:1990/Amd.1:1993 (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.

Amendment 1 to International Standard ISO 789-9:1990 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Sub-Committee SC 2, *Common tests*.

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Agricultural tractors – Test procedures –

Part 9 :
Power tests for drawbar

AMENDMENT 1

Page 3, subclause 6.3

The first paragraph reads as follows:

If the tractor is not fitted with a power take-off capable of transmitting full engine power, the drawbar power and speed shall be measured as a function of drawbar pull at full load. Operate the tractor, ballasted as for the tests in 6.2, at the speed ratio giving maximum drawbar power. Increase the drawbar pull until rated engine speed is obtained, and then increase the drawbar pull further, to reduce the engine speed in approximately 10 % intervals until either the drawbar pull reaches its maximum value, or the slip limits in 6.1 or some other limiting condition specified by the manufacturer is reached. For each increment of drawbar pull, record speed, drawbar power, wheel or track slip, engine speed and atmospheric conditions.

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Descriptors: agricultural machinery, tractors, agricultural tractors, drawbars, tests, mechanical power measurement.

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International Standard ISO 789-9 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*.

This first edition of ISO 789-9 transfers power tests for the tractor drawbar from ISO 789-1 : 1981 which is being revised at the same time.

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: Hydraulic power and 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*

Annexes A and B form an integral part of this part of ISO 789. Annexes C to F are for information only.

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INTERNATIONAL STANDARD ISO 789-9 : 1990 (E)

Agricultural tractors — Test procedures —

Part 9: Power tests for drawbar

1 Scope

This part of ISO 789 specifies test procedures for determining the power available at the drawbar on agricultural tractors of the wheeled, track-laying or semi-track-laying type.

The statement of power rating of the drawbar is specified in 6.4.

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 612 : 1978, *Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions.*

ISO 789-1 : 1990, *Agricultural tractors — Test procedures — Part 1: Power tests for power take-off.*

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 wheelbase: (See ISO 612.)

3.2 Tractor mass

3.2.1 basic tractor mass (unladen tractor): Mass of the tractor in working order with full tanks and radiators. Optional front and rear weights (ballast), tyre ballast, the tractor operator, mounted implements, mounted equipment or any specialized components are not included.

3.2.2 ballasted tractor mass (laden tractor): Mass of the tractor ballasted according to 5.7 for the performance test given in clause 6.

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

3.4 drawbar power: Power measured at the drawbar which can be sustained for at least 20 s, or the time needed to cover a distance of at least 20 m, whichever is longer.

3.5 maximum drawbar pull: Maximum horizontal drawbar pull at a drawbar hitch point recommended by the manufacturer and complying with the limitations set forth in 5.7, 6.1 and 6.2, which a tractor can sustain in its longitudinal axis.

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

3.7 dynamic radius index: Effective radius corresponding to the distance travelled by the tractor in one rotation of the driving wheels (i.e this distance divided by 2π), when the tractor is driven without drawbar load at a speed of approximately 3,5 km/h. (See ISO 4251-1.)

4 Measurement units and permissible tolerances

The following are used in this part of ISO 789:

— rotational frequency, in revolutions per minute	± 0,5 %
— time, in seconds	± 0,2 s
— distance, in metres or millimetres	± 0,5 %
— force, in newtons	± 1 %
— mass, in kilograms	± 0,5 %
— fuel consumption, in kilograms per kilowatt hour	± 1 %
— atmospheric pressure, in kilopascals	± 0,2 kPa
— tyre pressure (gauge), in kilopascals	± 5%
— temperature of fuels, etc., in degrees Celsius	± 2 °C
— wet and dry bulb thermometer temperatures, in degrees Celsius	± 0,5 °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 be the same as used in the PTO power tests (see ISO 789-1). Run-in shall be done with the governor set at full throttle and with the engine operating at rated speed.

Where the same tractor is used for the drawbar and PTO tests (see ISO 789-1), the fuel settings shall not be changed.

5.3 Fuels and lubricants

The compression-ignition (diesel) fuel used for the test shall be 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 annexes C, D and E respectively.)

The lubricants used for the test shall comply with the manufacturer's specification and be identified by trade-name, type and viscosity class. 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, a specific reference to these shall be given.

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, except as otherwise specified for a particular test. 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.

5.5 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 altitude, a modified carburettor or fuel pump setting may have to be used, details of which shall be included in the report.

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 which occurs during full load operation for 2 h of the tractor when fuel is taken from the tractor fuel tank. Efforts shall be made to limit the temperature variations throughout the tests. The fuel consumption shall be measured when the tractor traverses a straight track for a minimum distance of 100 m.

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 value shall then be used to calculate volumetric data using the fuel density at 15 °C.

Alternatively, when the consumption is measured by mass, calculate volumetric data using the fuel density value at 15 °C.

5.7 Ballasting and tyre pressures

Ballast (weight) which is commercially available and approved by the manufacturer for use in agriculture may also be fitted for wheeled tractors: liquid ballast in the tyre may also be used.

The overall static load on each tyre (including liquid ballast in the tyres and a 75 kg mass added to the tractor to represent the driver) and the inflation pressure shall be within the limits specified by the tyre manufacturer. Measure inflation pressure with the tyre valve in the lowest position.

6 Test procedure for drawbar test

6.1 General

Measure the drawbar performance of the tractor on one of the following surfaces:

a) for wheeled or rubber track tractors: a clean, horizontal and dry concrete or tarmacadam surface containing a minimum number of joints;

b) for steel track-laying tractors: flat, dry and horizontal mown or grazed grassland or on a horizontal surface having equally good adhesion characteristics;

c) a moving surface (rotating drum or treadmill), providing results are comparable to those obtained on the above surfaces.

State the type of surface in the report. If a rotating drum is used, report the diameter of the drum.

Do not make the tests in gears in which the forward speed exceeds the safety limits of the test equipment.

The line of pull shall be horizontal. The height of the drawbar shall remain fixed in relation to the tractor and shall be such that the tractor can be controlled at all times during the test. For wheeled tractors, the following formula applies:

$$H_{max} = \frac{0{,}8 \times W \times Z}{F}$$

where

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

Z is the wheelbase, in millimetres;

F is the drawbar pull, in newtons;

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

At the beginning of the drawbar test, the height of 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 B.

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

In the case of tractors having driving wheels not mechanically locked together, the revolutions of each wheel should be separately recorded and the slip calculated for each wheel. If the results for each wheel differ by more than 5 %, they should be checked and separately reported.

Slip of the driving wheels or tracks shall be determined by the following formula:

$$\frac{100\,(N_1 - N_0)}{N_1}$$

where

N_1 is the sum of the revolutions of all driving wheels or tracks for a given distance;

N_0 is the sum of the revolutions of all driving wheels or tracks for the same distance when the tractor is driven without drawbar load at a speed of approximately 3,5 km/h.

The slip of wheels or rubber tracks shall not exceed 15 % and that of steel tracks shall not exceed 7 %.

6.2 Transmission characteristic tests

Measure the maximum drawbar power in, if possible, at least six gears between that in which maximum pull can be developed, without exceeding the slip limits in 6.1, and that in which maximum power can be produced up to the gear closest to, but not exceeding, 16 km/h. The results shall include drawbar power, pull, speed, slip, fuel consumption and atmospheric conditions. Any noticeable wheel hop should be noted in the report with corresponding slip values at which it occurred. For steel track-laying tractors, report the maximum drawbar pull as a footnote beneath the table giving drawbar performance figures if the maximum pull occurs above 7 % slip.

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 but including that at which maximum power is obtained. Produce tables showing drawbar power, speed, wheel or track slip and fuel consumption as a function of drawbar pull.

6.3 Varying drawbar pull and speed at full load

If the tractor is not fitted with a power take-off capable of transmitting full engine power, the drawbar power and speed shall be measured as a function of drawbar pull at full load. Operate the tractor, ballasted as for the tests in 6.2, at the speed ratio giving maximum drawbar power. Increase the drawbar pull until maximum drawbar power is generated, and then increase the drawbar pull further, to reduce the engine speed in approximately 10 % intervals using the speed at maximum power as 100 % until either the drawbar pull reaches its maximum value, or the slip limits in 6.1.1 or some other limiting condition specified by the manufacturer is reached. For each increment of drawbar pull, record speed, drawbar power, wheel or track slip, engine speed and atmospheric conditions.

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 changes the gear ratio setting automatically with increasing drawbar pull, end the test at the first automatic ratio change.

6.4 Statement of power rating

The power rating of the tractor is usually stated as PTO power (see ISO 789-1 : 1990, clause 6.3). 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.

Annex A
(normative)

Specimen test report for drawbar

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: .....

Ignition 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

Gear						
Nominal travelling speed at rated engine speed with dynamic radius index (see 3.7), km/h						

Drawbar

Type: .....

Height above ground, max.: ..... mm; min.: ..... mm

Position relative to PTO: ..... mm

Steering

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

Wheels

Location of steering wheels: .....

Steering

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

Size: .....

Maximum permissible load: ..... kg Ply rating: .....

Track (tread) max.: ..... mm; min.: ..... mm

Inflation pressure: ..... kPa

Driving

Location of driving wheels: .....

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

Size: .....

Maximum permissible load: ..... kg Ply rating: .....

Track (tread) max.: ..... mm; min.: ..... mm

Inflation pressure: ..... kPa

Wheelbase:

..... mm

Tracks

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]) No.: .....

Octane number or cetane number: ..... Density at 15 °C: .....

Type: .....

Engine oil

Trade-name: ..... Type: .....

Viscosity class: .....

1) RON: Research octane number.

Transmission oil

Trade-name: ..... Type: .....

Viscosity class: .....

A.4 Varying drawbar pull and speed

Drawbar pull, kN						
Speed, km/h						
Drawbar power, kW						
Engine speed, min^{-1}						
Wheel or track slip						

Maximum drawbar pull (track-laying tractors only)

Maximum: ..... kN Track slip: ..... %

A.5 Drawbar test

Date of test: .....

Type of surface (or drum diameter): .....

Height of drawbar above ground: ..... mm

Gear	Speed	Power	Drawbar pull	Engine speed	Wheel or track slip	Noticeable wheel hop (yes/no)	Specific fuel consumption (optional)		Atmospheric conditions		
									Temperature	Relative humidity	Pressure
	km/h	kW	kN	min^{-1}			kg/kWh	kWh/l	°C	%	kPa
Maximum power at rated engine speed											
1											
2											
3											
etc.											
Maximum power at rated engine speed (optional)											
1											
2											
3											
etc.											

Annex B
(normative)

Drawbar tests — Measurement of tyre tread and track

The height of the tyre or rubber track tread bars (see 6.1) 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.

Annex C
(informative)

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

Characteristic	Limits and units	Test method
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 2192
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.

Annex D
(informative)

Reference fuel CEC RF-03-A-84 for compression-ignition engines — Specifications

Characteristic	Limit and units	Test method
Relative density 15 °C/4 °C (specific gravity)	0,84 ± 0,005	ISO 3675
Distillation		ISO 3405
50 % (volume)	245 °C min.	
90 % (volume)	330 °C ± 10 °C	
Final boiling point	370 °C max.	
Cetane index	51 ± 2	ISO 5165
Kinematic viscosity at 40 °C	3 cSt ± 0,5 cSt	ISO 3104
Sulfur content	min. to be reported max. 0,3 % (m/m)	ISO 2192
Flash point	55 °C min.	ISO 2179
Cloud point	−5 °C max.	ISO 3015
Conradson carbon residue on 10 % bottoms	0,2 % (m/m) max.	ISO 6615
Ash content	0,01 % (m/m) max.	ISO 6245
Water content	0,05 % (m/m) max.	ISO 3733
Copper corrosion	1 max.	ISO 2160
Strong acid number	0,2 mg KOH/g max.	ISO 6618
Oxidation stability	2,5 mg/100 ml	

NOTE — The CEC RF-03-A-84 reference fuel shall be based only on straight run distillates, hydrodesulfurized or not, and contain no additives.

Annex E
(informative)

Reference fuel CEC RF-08-A-85 for spark-ignition engines — Specifications — Premium gasoline unleaded

Characteristic	Limits and units	Test method[1)]
Research octane number (RON)	95 min.	ISO 5164
Motor octane number (MON)	85 min.	ISO 5163
Relative density 15 °C/4 °C (specific gravity)	0,755 ± 7	ISO 3675
Reid vapour pressure	60 kPa ± 4 kPa (600 mbar ± 40 mbar)	ISO 3007
Distillation		
Initial boiling point	32 °C ± 8 °C	
10 % (volume)	50 °C ± 8 °C	
50 % (volume)	100 °C ± 10 °C	
90 % (volume)	167,5 °C ± 12,5 °C	
Final boiling point	202,5 °C ± 12,5 °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 2192
Copper corrosion	1 max.	ISO 2160
Lead content	0,005 g/dm^3 max.	ISO 3830
Phosphorus content	0,001 3 g/dm^3 max.	ASTM D 3231
Carbon/hydrogen ratio	to be reported	ASTM D 3606, ASTM D 2267, ASTM D 1319
Use of oxygenates prohibited		

1) The national standards will be replaced by ISO references when corresponding International Standards have been adopted.

Annex F
(informative)

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[25] ASTM D 3231 : 1983, *Phosphorus in gasoline.*

[26] ASTM D 3606 : 1982, *Benzene and toluene in finished motor and aviation gasoline by gas chromatography.*

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