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IS 12036 (1995): Agricultural tractors - Test procedures - Power tests for power take off [FAD 11: Agricultural Tractors and Power Tillers]



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“Knowledge is such a treasure which cannot be stolen”

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के लिए पावर परीक्षण
(पहला पुनरीक्षण)

Indian Standard

**AGRICULTURALTRACTORS-TEST
PROCEDURES-POWERTESTSFOR
POWERTAKE-OFF**

(First Revision)

ICS 65'060'10

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Agricultural Tractors and Power Tillers Sectional Committee had been **approved by** the Food and Agriculture Division Council.

Power take-off (**PTO**) is one of the power outlets in Agricultural Tractors Testing of power at the **PTO** in one of the important characteristics in tractor testing. A need **was** therefore **felt to** prepare a detailed standard to provide uniform guidelines for conducting the tests. This standard **was** first published in 1987. This revision has been taken up to align the procedure **with** revised, **ISO** standard. This revision incorporates among other the following:

- a) General layout of the standard;
- b) Permissible tolerance for the measurement limits;
- c) Running in and preliminary adjustments;
- d) Specification of the fuel to be used for testing;
- e) Method for measurement of fuel consumption;
- f) Statement of power rating; and
- g) **Belt** pulley performance test (optional).

Though high **temperature** test has not been covered in **ISO**, keeping in view the prevalent situation **in** the country high ambient test has been retained in this revision.

In the preparation of this standard, considerable assistance has been derived from **ISO 789-1: 1990**.

In reporting the result of a test or analysis, made in accordance with this standard, if the **final** value, observed or calculated, is to be rounded **off**, it shall be done in accordance **with** **IS 2 : 1960** 'Rules for rounding off numerical values (revised) '.

Indian Standard

AGRICULTURAL TRACTORS—TEST PROCEDURES — POWER TESTS FOR POWER TAKE-OFF

(*First Revision*)

1 SCOPE

This standard specifies test procedures for determining the power available at the power take-off (PTO), and at the belt or pulley shaft, on agricultural tractors of the wheeled, track-laying or semi track-laying type.

The statement of the power rating of the PTO is specified in 6.3.

2 REFERENCES

The following standards contains provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below:

IS No.	Title
4931 : 1995	Agricultural tractors — Rear mounted — power take-off type 1, 2 and 3 (<i>third revision</i>)
5994 : 1987	Test code for agricultural tractor (<i>second revision</i>)
12226 : 1995	Agricultural tractors — Test procedure — Power test for drawbar (<i>first revision</i>)

3 DEFINITIONS

For the purpose of this standard, the definitions given in IS 5994 : 1987 shall apply.

4 MEASUREMENT UNITS AND PERMISSIBLE TOLERANCES

Measurement units and permissible tolerances as given in 4 of IS 5994 : 1987 shall apply.

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 specifications. Run-in shall be done with the governor set at full throttle and with the engine operating at rated speed. Run-in shall be done as per manufacturer's recommendations.

5.3 Fuels and Lubricants

Fuels and lubricants for the tests shall conform to 5.3 of IS 12226 : 1995.

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, in which case this shall be recorded in the test report.

Power variations during tests caused by these devices exceeding ± 5 percent 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. The surrounding temperature shall be $27 \pm 7^\circ\text{C}$.

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

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

6 TEST PROCEDURE

6.1' Power Take-off Test

Tests shall be carried out at one or more PTO's as specified by the manufacturer on all tractors having a PTO as specified in IS 4931 : 1995. The tests shall include one on a power take-off capable of transmitting the full power of the engine if such a PTO is available.

6.1.1 General

The various tests shall normally be carried out continuously.

The angle of the connection of the shaft connecting the PTO 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.

6.1.2 Power

6.1.2.1 Maximum power absolute

Operate the tractor at the engine speed where maximum power occurs for a period of 2 h subsequent to a warming-up period to reach stabilized running conditions. Measure the power, torque and fuel consumption.

The maximum power quoted in the test report shall be the average of at least six readings made at regular intervals during the 2 h period. If the power varies by more than ± 2 percent from the average, repeat the test. If the variation continues, report the deviation.

For a tractor not fitted with a PTO capable of transmitting the full power of the engine, operate it for 2 h at a power specified by the manufacturer. If possible, a 20 percent increase in power shall be applied every 5 min for a period of 1 min. If the engine can not develop the 20 percent increase in power, carry out the intermittent test at full engine power. Omit the test described in 6.1.3 and 6.1.4.

6.1.2.2 Maximum power at rated engine speed (optional)

If maximum power does not occur at rated engine speed, an optional additional 1 h test should be carried out using the procedure stated, in 6.1.2.1.

6.1.3 Varying Speed at Full Load

Measure the power, torque and fuel consumption as a function of speed at full power at approximately 10 percent speed increments. The minimum speeds at which measurements are made shall be at the speed of maximum torque and, if possible, 15 percent below that speed.

6.1.4 Varying Load Tests

Measure the power, speed and fuel consumption at the values listed below of torque with the governor control set for maximum power, firstly, at the rated engine speed and secondly, at the standard speed appropriate to the design of the PTO that is either 540 min^{-1} or $1\ 000 \text{ min}^{-1}$ (see IS 4931 : 1995):

- a) The torque corresponding to maximum power available at rated engine speed and at standard PTO speed;
- b) 85 percent of the torque obtained in (a);
- c) 75 percent of the torque obtained in (b);
- d) 50 percent of the torque obtained in (b);
- e) 25 percent of the torque obtained in (b); and
- f) Unloaded [with the dynamometer disconnected if the residual torque is greater than 5 percent of the torque defined in (b)].

6.1.5 Presentation of Results

The data in 6.1.1 to 6.1.4 shall be reported in tabular form for each test condition. If also presented in graphical form (which is optional), the following, covering the full range of engine speeds tested, shall be included:

- Power as a function of speed;
- Torque as a function of speed;
- Fuel consumption (mass) and specific fuel consumption (mass) as a function of speed; and

- Specific fuel consumption (mass) as a function of power.

Report the no-load maximum engine speed.

6.1.6 Additional Measurements

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

- Ambient air temperature at a representative point: this is taken to be approximately 2 m in front or to the side of the tractor, depending upon the location of the suction or blower device on the tractor, and approximately 1.5 m above the ground. For a tractor fitted with a pusher fan, the point is approximately 2 m behind the tractor and approximately 1.5 m above the ground;
- Air temperature at the engine air intake;
- Atmospheric pressure;
- Relative air humidity;
- Maximum coolant temperature (in the case of an aircooled engine, measure the temperature of the cylinder block at representative points);
- The fuel temperature at the inlet to the carburettor or injection pump; and
- Engine oil temperature.

6.1.7 Test at High Ambient Temperature

The test given under 6.1.3, 6.1.2.1 and 6.1.2.2 shall be conducted under high ambient temperature of $43 \pm 2^\circ\text{C}$. The power, torque and fuel consumption shall be reported. The lubricating oil consumption on mass basis; during maximum power test (see 6.1.2.1) at high ambient shall be measured and reported. The observations given under 6.1.6 shall also be reported.

6.2 Belt or Pulley Shaft Tests (Optional)

At the manufacturer's request, the power available at the belt or pulley shaft of tractors, if fitted, may be measured.

Connect the tractor pulley to that of the dynamometer by a flexible belt having appropriate power and torque transmission characteristics. Belt slip, when calculated from the following formula; shall not exceed 2 percent and the tension necessary to prevent this shall be as small as possible.

Belt slip shall be determined by the following formula:

$$\frac{100 (n_0 - n_1)}{n_0}$$

where

n_0 is the number of revolutions per minute of the driven pulley without slip; and

n_1 is the number of revolutions per minute of the driven pulley under load.

All the provisions for tests at the main PTO with the exception of those at standard PTO speed and for tractors unable to transmit the full engine power at the PTO shall apply to the belt or pulley shaft.

If the rated engine speed does not correspond to a standard belt speed, measure the performance of the engine at the speed corresponding to the standard belt speed of $15.75 \text{ m/s} \pm 0.25 \text{ m/s}$.

6.3 Statement of Power Rating

The power rating of the tractor shall be stated as the maximum power measured at a PTO capable of transmitting the full power of the engine. If the tractor is not fitted with a PTO capable of transmitting the full power of the engine, the power measured at other PTO points may be used, but shall be clearly identified in the test report.

NOTE — If there are no PTO points capable of transmitting the full power of the engine, the power rating of the tractor is stated as the power measured at the drawbar (see IS 12226 : 1995).

ANNEX A

(Clause 5.1)

SPECIMEN TEST REPORT FOR POWER TAKE-OFF

A-1 LOCATIONS

Tractor manufacturer's name and address:

Place of running in:

Duration of running in:

A-2 SPECIFICATION OF TRACTOR

Tractor

Model: **Sl. No.:**

Engine

Make: Model:

Type: Sl 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:

Cooling System

Type constant/intermittent (delete)

If intermittent, mode during test:

Power Take-of

Location: Dimensions: mm
 Type of drive: Number of splines:
 Height above ground mm
 Speed at: min^{-1} Corresponding engine speed: min^{-1}

(Repeat for each power take-off if more than one)

Belt Pulley

Location: Dimensions: mm
 (diameter and width)
 Type of drive:
 Linear speed of pulley: m/s Corresponding engine speed: min^{-1}
 Height above ground: mm Location from tractor centreline:..... mm

A-3 FUEL AND LIJBRICANT SPECIFICATIONS — LABORATORY TESTS

Fuel

Trade-name: Octane (**RON**¹⁾ No:
 Octane number or **cetane** index: Density at 15°C:
 Type:

Engine Oil

Trade-name: Type:

Viscosity class;

Transmission Oil

Trade-name: Type:

Viscosity class:

A-4 DATA TESTS

Date and location of test:

¹⁾RON: Research Octane Number.

Type of dynamometer:

Power kW	Speed min ⁻¹		l/h	Fuel Consumption		
	Engine	PTO		kg/h	kg/kWh	kWh/l
Maximum power absolute (6.1.2.1)						

Rated engine speed with varying load [6.1.2.2, and 6.1.4(a)](Optional)

- a)
- b)
- c)
- d)
- e)
- f)

Varying speed at full load (6.1.3)

Standard speed with varying loads (6.1.4)

- a)
- b)
- c)
- d)
- e)
- f)

No-load maximum engine speed: min⁻¹

Equivalent crankshaft torque: Nm:

Maximum equivalent crank shaft torque Nm: at.....min⁻¹ engine speed

Mean atmospheric conditions:

Temperature at air intake: °C Ambient temperature°C

Relative humidity: % Pressure, kPa

Maximum temperature of **coolant**: °C

Engine oil temperature: °C

NOTE — The Table in A-4 may also be used with appropriate modifications to report the results of belt and belt pulley tests.

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