

Indian Standard

AGRICULTURAL TRACTORS — POWER TESTS FOR DRAWBAR — TEST PROCEDURE

(*First Revision*)

1 SCOPE

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

1.1.1 The statement of power rating of the drawbar is specified in 6.5.

2 NORMATIVE REFERENCES

The standards given in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were 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 editions of the standards indicated in Annex A.

3 DEFINITIONS

For the purpose of this standard, the following definitions shall apply.

3.1 **Wheelbase** — (*See* 2.2 of IS 5994 : 1987).

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 6.

3.3 **Rated Engine Speed** — (*See* 2.7 of IS 5994 : 1987).

3.4 **Drawbar Power**

Power measured at the drawbar which can be sustained for at least 20s, or the time needed to

cover a distance of at least 20m, 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** — (*See* 2.13 of IS 5994 : 1987).

3.7 **Dynamic Radius Index/Type Rolling Radius** — (*See* 2.14 of IS 5994 : 1987).

4 MEASUREMENT UNITS AND PERMISSIBLE TOLERANCES

For the purpose of this standard, the 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 B) 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* IS 12036 : 1995). 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 (*see* IS 12036 : 1995), 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 (see Annex C).

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.

NOTE — In case reference fuel as specified is not available the testing authority should indicate in the test report the corresponding characteristics of the fuel used in testing.

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 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.

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 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 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 in a horizontal surface having equally good adhesion characteristics; and
- 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 test 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:

$$H_{\text{Max}} = \frac{0.8 \times W \times Z}{F}$$

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, and

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

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

The atmospheric temperature at the test track shall be $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$.

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 percent, 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, and

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 percent and that of steel tracks shall not exceed 7 percent.

6.2 Transmission Characteristic Test

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 foot note beneath the table giving drawbar performance figures if the maximum pull occurs above 7 percent 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 percent intervals using the speed at maximum power as 100 percent 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 Ten-Hour Test

For wheeled tractors, ballasted in accordance with 5.7, five-hour test given in 6.4.1 shall be conducted followed by another five-hour test given in 6.4.2 with a minimum of time interval. For track laying tractors, the test given

at 6.4.1 shall be conducted for 10 hours instead of 5 hours.

6.4.1 Five-hour Test at 75 percent of the Pull at Maximum Power

The ballasted wheeled tractor shall be operated for 5 hour in a gear normally used for agricultural work, such as ploughing. The drawbar pull shall be 75 percent of the pull at maximum power in that gear. Values of the power, speed, slip, fuel consumption, and temperature of fuel, coolant and lubricating oil, and atmospheric conditions (temperature, pressure and relative humidity) shall be reported.

6.4.1.1 If the tractor is fitted with hydrokinetic torque converter which can be 'locked out' by the driver, the test shall be carried out with the torque converter in operation, within the limitations specified by the manufacturer in his published instructions. If the limiting conditions for operation of the torque converter are reached, the test shall be completed with the torque converter 'locked out'. The respective durations of the two parts of the test shall be noted in the test report and the corresponding fuel consumption shall be separately reported. For four wheel drive tractors, test with four wheel drive engaged shall be carried out.

6.4.2 Five-hour Test at the Drawbar Pull Coinciding with 15 percent Wheel Slip

The ballasted wheeled tractor shall be operated for 5 hours at the drawbar pull giving 15 percent wheelslip measured during the test specified

in 6.2. The gear used shall be the fastest gear in which the required pull can be obtained when the engine is operating under the control of the governor. If necessary, supplementary ballast may be added to reduce the wear of the tyres and to facilitate control of the tractor. The drawbar pull, speed and atmospheric conditions (temperature, pressure and relative humidity) shall be reported.

6.4.2.1 If the tractor is fitted with hydrokinetic torque converter which can be 'locked out', by the driver, the test shall be carried out with the torque converter in operation, within the limitations specified by the manufacturer in his published instructions. If the limiting conditions for operation of the torque converter are reached, the test shall be completed with the torque converter, 'locked out'. The respective durations of the two parts of the test shall be noted in the test report. For four wheel drive tractors, test with four wheel drive engaged shall be carried out.

NOTE — If the tractor does not develop sufficient power to reach the drawbar pull coinciding with 15 percent wheel slip measured during the test specified in 6.2 the test shall be carried out at the maximum drawbar pull.

6.5 Statement of Power Rating

The power rating of the tractor is usually stated as PTO power (see IS 12036 : 1995). 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

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
1448	Methods of test for petroleum and its products	[P : 21] : 1992	Flash point (closed) by pensky-martens apparatus (second revision)
[P : 2] : 1971	Acidity (first revision)	[P : 25] : 1976	Determination of kinematic and dynamic viscosity (first revision)
[P : 4] : 1984	Ash, sulphated ash and water soluble ash (second revision)	[P : 32] : 1992	Density and relative density (first revision)
[P : 8] : 1967	Carbon residue by Ramsbottom method (first revision)	[P : 33] : 1991	Sulphur by bomb method (second revision)
[P : 9] : 1960	Cetane number	[P : 40] : 1987	Water by distillation (third revision)
[P : 10] : 1970	Cloud point and pour point (first revision)	5994 : 1987	Test code for agriculture tractors
[P : 15] : 1976	Detection of copper corrosion from petroleum product by the copper strip tarnish test (second revision)	12036 : 1995	Agricultural tractors — Test procedures — Power tests for power take-off
[P : 18] : 1991	Distillation (second revision)		
[P : 20] : 1982	Flash point by Abel apparatus (first revision)		