

BRITISH STANDARD TESTS FOR INDUSTRIAL CRAWLER & WHEELED TRACTORS

(excluding units designed for materials
handling in factories)

B.S. 2800 : 1957



BRITISH STANDARDS INSTITUTION

Incorporated by Royal Charter

2 PARK STREET, LONDON W1A 2BS



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Telex: 266933

Telephone: 01-629 9000

Full document details: BS 2800:1957

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THIS BRITISH STANDARD, having been approved by the Road Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 16th May, 1957.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 2500, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook, price 15s.

This standard makes reference to the following British Standards :

B.S. 1744. Tests for agricultural tractors.

B.S. 2596. Components of crawler tractors and earth moving equipment.

B.S. 2869. Oil fuels



British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard :—
Committee reference RDE/21 Draft for comment CV(RDE) 7381
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CO-OPERATING ORGANIZATIONS

The Road Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations :—

Air Ministry

Asphalt Roads Association

British Road Tar Association

British Tarpaviors' Federation

Cement and Concrete Association

*Contractors Plant Association

*County Surveyors' Society

*D.S.I.R.—Road Research Laboratory

*Federation of Civil Engineering Contractors

Federation of Coated Macadam Industries

*Federation of Manufacturers of Contractors' Plant

Institute of Petroleum

*Institution of Civil Engineers

*Institution of Highway Engineers

*Institution of Municipal Engineers

Institution of Structural Engineers

*Ministry of Transport and Civil Aviation

Road Emulsion Association

Roads Improvement Association

Sand and Gravel Association of Great Britain

Society of Chemical Industry

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard.

D.S.I.R.—Building Research Station

Industrial Truck Manufacturers Association

Ministry of Supply

Ministry of Works

National Institute of Agricultural Engineering

War Office

Tractor manufacturers



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BRITISH STANDARD

TESTS FOR INDUSTRIAL CRAWLER AND WHEELED TRACTORS

(EXCLUDING UNITS DESIGNED FOR MATERIALS
HANDLING IN FACTORIES)

FOREWORD

The British Standard Tests for Agricultural Tractors (B.S. 1744), which are based on a similar test scheme initiated many years ago in the U.S.A., have several shortcomings as a means of expressing the performance of industrial type tractors. Firstly, while it has been the practice to quote the belt horsepower of industrial tractors it is not the custom to use this class of tractor for belt work and it would therefore be better practice to quote the installed horsepower of the engines. Hence the details of belt tests given in Section One of B.S. 1744 are seldom applicable. Secondly, B.S. 1744 does not provide for tests designed to investigate the suitability of a tractor for operation on severe gradients. Thirdly, the tractor specification details outlined in Section Three of B.S. 1744 do not include all those which are of particular importance in the case of industrial tractors. The present standard has therefore been prepared to provide a series of tests applicable to industrial type tractors, not including those types specifically designed for agricultural use or for towing trailing loads in industrial premises.

Specimen copies of the appropriate forms of record for tests of tractors with spark-ignition and compression-ignition engines are given in this standard.

GENERAL

SCOPE

1. This British Standard provides for the following tests for crawler and wheeled tractors : engine performance, field tests for drawbar performance when pulling loads on a good level surface and a static tilting test in order to verify the manufacturer's claim regarding the maximum angles at which the engine may be run satisfactorily ; such tests are thought to be the best practical criterion. It is envisaged that tractor tests according to this standard will be carried out by a recognized authority such as a National Testing Authority or, alternatively, that the standard will form a basis for acceptance tests made at the request of a purchaser.

PREPARATION FOR TESTING

2. Before commencing the tests, the Testing Authority shall be satisfied that the complete tractor has been satisfactorily run-in.

SECTION ONE : ENGINE TESTS

3. The engine tests shall be carried out with the engine in the installed condition either in the tractor or on a test bench, and all ancillary engine equipment, such as radiator, fan, cowlings, water pump, dynamo, air inlet filter and exhaust system shall be fitted. In particular, the arrangements for cooling and for fuel supply to the engine shall be substantially the same as in the installed condition ; for compression-ignition engines, the standard fuel injection equipment for the engine concerned shall be fitted and the injection pump shall be as set by or for the tractor manufacturers for normal specified operation.

4. The tractor engine shall be mechanically coupled from the flywheel to a dynamometer or shall be installed in the tractor with the dynamometer coupled to the p.t.o. shaft if this is directly coupled to the crankshaft. The horsepower recorded throughout the test shall be the horsepower delivered at the dynamometer, with no allowance for mechanical losses between the crankshaft and dynamometer. If a fluid coupling is fitted it shall be locked or removed and replaced by a solid coupling acceptable to the engine manufacturer.

5. For tractors equipped with compression-ignition engines, no correction for atmospheric conditions shall be made to the results, because of the divergence of opinion as to a suitable correction formula. The mean atmospheric temperature, pressure and humidity measured during the tests shall be recorded in the table of results.

For spark-ignition engines, the power developed shall be corrected by means of the following formula :

$$\text{Corrected h.p.} = \text{measured h.p.} \times \sqrt{\frac{460 + t}{520}} \times \frac{29.53}{p_b - p_w}$$

where t = atmospheric temperature (°F)

p_b = atmospheric pressure (inHg)

p_w = observed water vapour pressure (inHg).

6. The rated speed of an engine is the crankshaft speed at which the tractor manufacturer specifies it should be run when developing the maximum horsepower for the role in which the engine is to be used.

7. The complete engine test of a tractor with a spark-ignition engine shall be made with the fuel settings normally supplied as standard. If optional rich mixture settings are recommended, a further test may be made to determine the Maximum Power (Rich Mixture). If this rich mixture setting is not recommended by manufacturers for the Maximum Power Test (Rich Mixture), see A in Table 1, then the Maximum Power Test (Normal Mixture), see B in Table 1, shall be of two hours' duration.

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8. The engine governor setting for any test under the control of the governor shall be such that the governed speed, when under a load corresponding to 85 per cent of the maximum horsepower developed at rated speed, does not exceed the rated speed by more than 10 per cent. If the governor setting is such that maximum power occurs within the range, rated speed $+ 2\frac{1}{2} - 0$ per cent, then E in Table 1 and D in Table 2 may be omitted.

9. In any test, curves of horsepower/speed, fuel/equivalent crankshaft torque/speed, fuel consumption/speed and specific fuel consumption/horsepower shall be drawn for the full range of engine speed available. Fuel consumption in gallons per hour shall be measured by a volume/time method. In calculating specific fuel consumption, the observed values of fuel consumption and horsepower shall be used. Typical curves are shown in Figs. 1 and 2.

The specific fuel consumption values are reported as weight of fuel per hour per unit of work. To obtain values of the volume of fuel per hour and work per unit of volume, the conversion of units of weight to units of volume shall be made using the specific gravity of the fuel at 60°F.

When fuel consumption is measured by volume, the specific fuel consumption shall be calculated using the specific gravity of the fuel at the appropriate temperature.

10. The temperatures of fuel, coolant, intake air, atmospheric air and lubricating oil shall be recorded in the table of results. Fuel temperature shall be read at the outlet of the volume/time measurement apparatus; coolant temperature shall be read on the engine side of the thermostat; intake air temperature shall be read at the air cleaner inlet; atmospheric temperature shall be read 6 ft (1.83 m) from and normal to the radiator air intake; lubricating oil temperature shall be measured at the oil cooler inlet, where applicable, or in the engine sump.

11. The curves referred to in Clause 9 shall be obtained from the results of a number of test runs at various engine loads, each run being of at least 20 minutes' duration. The varying load conditions to be tabulated are as follows:

- (i) Maximum operating power.
- (ii) 75 per cent of (i).
- (iii) 50 per cent of (i).
- (iv) 25 per cent of (i).
- (v) No load.

A run of two hours' duration shall be made at the load at which maximum power is developed and a run of one hour's duration shall be made at 85 per cent of maximum power at rated speed.

12. The results of the tests shall be presented in the form shown in Table 1 for spark-ignition engines and in the form shown in Table 2 for compression-ignition engines.

The letters A to E and the figures (i) to (v) in the tables are for ease of reference and are not intended for inclusion in the final published test results.

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TABLE 1.
SPARK-IGNITION ENGINE TEST PERFORMANCE AT $\left\{ \begin{array}{l} \text{CRANKSHAFT} \\ \text{P.T.O. SHAFT} \end{array} \right\}$
Rated engine speed rev/min.

Horse-power	Speed rev/min	Fuel consumption			Temperatures (°F)					Atmospheric pressure inHg
		Imperial gallons per hour	h.p. hours per Imperial gallon	Lb/h.p. hour	Fuel	Coolant	In-take air	Atmospheric	Lubricating oil	

A. Maximum Power (Rich Mixture)—Two-hour Test

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Maximum $\left\{ \begin{array}{l} \text{crankshaft} \\ \text{equivalent crankshaft} \end{array} \right\}$ * torque (rich mixture) : lb ft at rev/min.

B. Maximum Power (Normal Mixture)—One-hour Test

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Maximum $\left\{ \begin{array}{l} \text{crankshaft} \\ \text{equivalent crankshaft} \end{array} \right\}$ * torque (normal mixture) : lb ft at rev/min.

C. 85 per cent of Maximum Power (Normal Mixture)—One-hour Test

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D. Varying Load (Normal Mixture)

(i)										
(ii)										
(iii)										
(iv)										
(v)										

E. Maximum Power at Rated Speed (Normal Mixture)

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* Strike out whichever is inapplicable.

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TABLE 2.
COMPRESSION IGNITION ENGINE TEST PERFORMANCE AT
{CRANKSHAFT *}
{P.T.O. SHAFT *}

Rated engine speed rev/min.

Horse- power	Speed rev/ min	Fuel consumption			Temperatures (°F)					Atmos- pheric pressure in/lb
		Imperial gallons per hour	h.p. hours per Imperial gallon	Lb/h.p. hour	Fuel	Coolant	In- take air	Atmos- pheric	Lubri- cating oil	

A. Maximum Power—Two-hour Test

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Maximum { crankshaft
equivalent crankshaft } * torque : lb ft at rev/min.

B. 85 per cent of Maximum Power—One-hour Test

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C. Varying Load

(i)										
(ii)										
(iii)										
(iv)										
(v)										

D. Maximum Power at Rated Speed

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* Strike out whichever is inapplicable.

SECTION TWO : DRAWBAR TESTS

13. Drawbar tests on tracklaying tractors shall be carried out on dry, level, mown or grazed grassland on a clay soil or on a track having equally good adhesion characteristics. As a guide to suitable track conditions, the cohesive strength of the soil should be not less than 7 lb/sq in. (0.5 kg/sq. cm) at a depth of 2 in. (50.8 mm) and should preferably not exceed 12 lb/sq. in. (0.84 kg/sq. cm). These data refer to measurements made in situ by a torsional shear test, details of which are given in the Appendix.

For pneumatic-tyred tractors drawbar tests shall be carried out on a level, dry bituminous or concrete surface.

14. The tractor shall be coupled through a drawbar dynamometer to some convenient form of drawbar load and the line of draught shall be parallel to the ground. The drawbar horsepower recorded throughout the tests shall be the horsepower developed at the drawbar without any allowance for losses due to track or wheel slip.

15. The drawbar tests shall be carried out with the drawbar hitch point at the height above ground level which is recommended by the manufacturers. The height of the drawbar hitch point above ground during the tests shall be measured to the centre of the drawbar clevis and shall be recorded in the tractor specification given in the report.

16. The tractor may be equipped for drawbar tests with any track or wheel equipment which is commercially available, together with any ancillary equipment such as winch, hydraulic pump and cylinders, harness and blade, radiator guard, power take-off and control unit.

For pneumatic tyred tractors the total static weight on any tyre shall not exceed the maximum recommended by the tyre manufacturers and the tyres shall be inflated in accordance with the load and pressure schedule of the tyre manufacturer.

17. No correction for atmospheric conditions shall be made to the results, but the mean atmospheric temperature, pressure and humidity measured during the tests shall be recorded in the table of results.

18. The governor shall be in operation throughout the drawbar tests and the governor setting shall be in accordance with Clause 8. If the governor setting is such that maximum power occurs within the range, rated speed $+ 2\frac{1}{2} - 0$ per cent, then C in Table 3 and B in Table 4 may be omitted.

19. The drawbar tests in all working gears for a tractor with a spark-ignition engine shall be made with the fuel settings normally supplied as standard. If optional rich mixture settings are recommended, a further test in the gear to be designated by the manufacturer may be made to determine the Maximum Drawbar Power (Rich Mixture).