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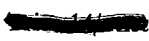
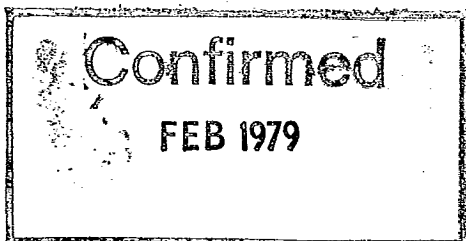
METRIC UNITS

**METHODS OF TESTING
SMALL SPARK IGNITION
ENGINES FOR
AGRICULTURAL USE**

BRITISH STANDARDS INSTITUTION

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SMALL SPARK IGNITION
ENGINES FOR
AGRICULTURAL USE

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BRITISH STANDARDS INSTITUTION

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THIS BRITISH STANDARD, having been approved by the Mechanical Engineering Industry Standards Committee, was published under the authority of the Executive Board on 26th January, 1970.

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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 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, price 20s. The BS Yearbook may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- BS 1701. Filters for air supply to internal combustion engines and compressors (other than aircraft).
- BS 3425. Method for the measurement of noise emitted by motor vehicles.
- BS 3489. Sound level meters (industrial grade).

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 BSI references relate to the work on this standard:
Committee reference MEE/174 Draft for comment D65/8676

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CO-OPERATING ORGANIZATIONS

The Mechanical 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:

Associated Offices' Technical Committee
 Association of Consulting Engineers
 Association of Mining Electrical and Mechanical Engineers
 Board of Trade
 British Chemical Plant Manufacturers' Association
 British Compressed Air Society
 British Electrical and Allied Manufacturers' Association
 British Gear Manufacturers' Association
 *British Internal Combustion Engine Manufacturers' Association
 British Mechanical Engineering Federation
 British Pump Manufacturers' Association
 British Steel Industry
 *Crown Agents for Oversea Government and Administrations
 Department of Employment and Productivity (H.M. Factory Inspectorate)
 Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales
 Engineering Equipment Users' Association
 Gas Council
 Institute of Marine Engineers
 Institution of Civil Engineers
 Institution of Gas Engineers
 Institution of Heating and Ventilating Engineers
 *Institution of Mechanical Engineers
 Institution of Mechanical Engineers (Automobile Division)
 Institution of Production Engineers
 Locomotive and Allied Manufacturers' Association of Great Britain
 London Transport Board
 Machine Tool Trades Association
 Ministry of Defence
 *Ministry of Defence, Army Department
 Ministry of Power
 Ministry of Public Building and Works
 Ministry of Technology
 Ministry of Technology—National Engineering Laboratory
 Ministry of Transport
 National Coal Board
 National Physical Laboratory (Ministry of Technology)
 Royal Institute of British Architects

The Government department 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:

Agricultural Engineers Association Limited
 Agricultural Machinery and Tractor Dealers Association
 Ministry of Agriculture, Fisheries and Food
 National Farmers' Union
 National Institute of Agricultural Engineering

BRITISH STANDARD METHODS OF TESTING SMALL SPARK IGNITION ENGINES FOR AGRICULTURAL USE

FOREWORD

This British Standard, which has been prepared under the authority of the Mechanical Engineering Industry Standards Committee of the British Standards Institution, is one of a series covering the testing and the performance of internal combustion engines. Other standards in the series are:

BS 649. The performance of reciprocating compression-ignition (diesel) engines, utilizing liquid fuel only, for general purposes.

BS 765. Internal combustion engines, spark ignition type.

BS 1744. Tests for agricultural tractors.

BS 2800. Tests for industrial crawler and wheeled tractors (excluding units designed for materials handling in factories).

BS 2953. Diesel engines for rail traction.

BS AU 141. The performance of diesel engines for road vehicles.

The purpose of the standard is to provide methods for testing small spark ignition engines of the types used in agriculture, horticulture and forestry. The tests are designed to determine the performance characteristics of the engine and to assess its capability under certain specified adverse conditions of temperature, humidity and dust.

This standard is based on, and is consistent with, the Draft 'Standard code for the official testing of small engines used in agricultural and commercial horticulture', which has been prepared by the Organization for Economic Co-operation and Development (O.E.C.D.).

NOTE. Attention is drawn to the use of the kilowatt as the unit of power instead of the previously used term horsepower. This is in accordance with a decision taken by BSI to adopt the International System (SI) of units for all standards in the future.

METHODS

1. SCOPE

This British Standard provides methods for testing small spark ignition internal combustion engines of the types used in agriculture, horticulture and forestry, but excluding engines which are not functionally self-sufficient.

The tests included cover the power output, endurance, sound levels, starting under varying conditions and operation under adverse conditions of temperature,

humidity and dust concentration. A specimen test report and performance curves are included in the appendices.

2. DEFINITIONS

For the purposes of this British Standard the following definitions apply:

- (1) *Rated speed*. The maximum engine speed in rev/min specified by the engine manufacturer for operation at nominal full continuous load.
- (2) *Maximum no-load speed*. The maximum engine speed recommended by the manufacturer in his published literature.
- (3) *Brake power*. The output power as measured by dynamometer at the output shaft of the engine, the engine being fully equipped for normal operation.
- (4) *Maximum power*. The greatest power which the engine can develop, whether at the rated speed or at any other speed.
- (5) *Specific fuel consumption*. The weight of fuel consumed per unit of work.
- (6) *Nominal full continuous load*. The greatest output power at rated speed recommended by the manufacturer for continuous operation.

3. SELECTION AND PREPARATION OF ENGINES FOR TESTING

3.1 Two engines to be tested shall be selected by the testing personnel who will ensure that they conform to the production specifications. This shall be verified in the test report. If the engines are prototypes, this shall be stated in the test report. Where an engine is offered as several variants, the description of the engine in the test report shall make it clear that the report applies only to the variant(s) tested.

3.2 The engines shall be new and all details, accessories such as air cleaner, exhaust system, radiator generator, starter, etc., and settings (where applicable) necessary to perform their intended function unaided shall be as given in the specification for each engine in its particular variant. Compliance with this shall be stated in the test report.

3.3 During all tests, the engines shall be operated strictly in accordance with the engine maker's instructions.

4. RUNNING-IN PROCEDURE AND MAINTENANCE

4.1 Running-in. The engines shall be run-in by the testing personnel according to the running-in procedure, if any, specified by the engine manufacturer. Where no such procedure is given, or if they are not explicit, the following running-in procedure shall be used, all at rated speed:

- (1) $\frac{1}{2}$ hour at $\frac{1}{4}$ nominal full continuous load, then
- (2) 1 hour at $\frac{1}{2}$ nominal full continuous load, then
- (3) $7\frac{1}{2}$ hours at $\frac{3}{4}$ nominal full continuous load, and then
- (4) 1 hour at nominal full continuous load.

4.2 Maintenance. Throughout the tests the testing personnel shall carry out fully the directions given in the operator's manual for all maintenance, including periodic oil changes, decarbonizing and routine adjustments (see 12.2). The lubricating oil used shall be in accordance with the manufacturer's published recommendation.

5. ACCURACY OF MEASURING EQUIPMENT

The measuring equipment used during all tests shall be accurate to within the following limits of test readings:

- | | |
|--------------------------|--------------------------|
| (1) Engine speeds | $\pm 0.5 \%$ |
| (2) Time | $\pm 0.2 \text{ s}$ |
| (3) Atmospheric pressure | $\pm 0.2 \text{ mbar}^*$ |
| (4) Temperature | $\pm 2^\circ \text{C}$ |
| (5) Torque load | $\pm 2 \%$ |

6. TEST FUEL

6.1 Unless the engine maker specifies a particular fuel for normal engine use, the fuel used for testing an engine shall be taken from a stock of typical fuel supplied for agricultural purposes. The characteristics of this fuel shall be recorded in the test report. The fuel shall have been delivered within three months of the date of the test.

6.2 The grades of fuel and lubricating oil used shall be appropriate to the tests being carried out.

7. STANDARD OPERATING REFERENCE CONDITIONS AND CORRECTION

7.1 The standard operating reference conditions are:

- (1) Mean barometric pressure: 1013 mbar* (760 mmHg)
- (2) Air temperature at inlet: 20°C

7.2 Correction. Where an engine test is carried out under atmospheric conditions other than those specified in 7.1, the measured power output shall be corrected using the following formula:

* 1 mbar (millibar) = 10^3 N/m^2 .

$$\text{Corrected power} = \text{measured power} \times \sqrt{\frac{273 + t}{293}} \times \frac{1013}{P_b}$$

where t = observed air temperature in °C

P_b = atmospheric pressure in mbar*

8. COMPULSORY TESTS—SEQUENCE

8.1 The following tests shall be carried out in the sequence stated (two engines are required for the tests):

8.1.1 *First engine*

- (1) Power (Clause 9).
- (2) Starting (Clause 10).
 - a. Hot start (10.2).
 - b. Under damp conditions (dew test) (10.3).
 - c. Cold start (10.4).
- (3) Sound level (Clause 11).
- (4) Endurance (Clause 12).

8.1.2 *Second engine*

Moderate density dust conditions (Clause 13).

NOTE. If any of the optional tests given in Clause 14 are made, these may be combined or interposed with the compulsory tests, as convenient.

9. POWER TESTS

9.1 The power output shall be determined:

- (1) after the running-in period, and
- (2) at the end of the endurance test, after any service or overhaul (see 12.2).

9.2 **General requirements.** Stable operating conditions shall be attained at each load setting before recording test measurements.

During the tests the engine shall be mounted in accordance with the engine maker's instructions. The power recorded shall be the power delivered at the dynamometer. The cardan shaft or coupling between engine and dynamometer shall be operated without appreciable angular deviation.

During power and fuel consumption measurements engines consuming liquid fuel shall be supplied from a fuel apparatus having a free fuel surface at the same level as the mean surface level in the engine fuel tank and connected to the engine by a piping arrangement as similar as possible to that on the engine. In

* 1 mbar (millibar) = 10^3 N/m².

the case of engines operating on liquefied petroleum gas, the gas control valve shall be in the position on the engine recommended by the engine maker.

If an extraction system is used for the removal from the laboratory of the exhaust gases it shall be arranged in such a manner that it does not affect the engine performance.

9.3 Governor. The governor, if fitted, shall be in operation with the governor control in the position recommended by the engine manufacturer.

If a governor is fitted which does not permit the maximum power from the engine to be determined, an additional test may be carried out under full throttle.

9.4 Temperature measurements. The temperature of the fuel, intake air, atmospheric air and, where applicable, lubricating oil shall be recorded and reported in the test report.

The fuel temperature shall be measured at the outlet of the volume/time or mass/time measurement apparatus which shall be so placed that this temperature shall be substantially the same as that of the fuel in the engine fuel tank.

The intake air temperature shall be read at the inlet to the air cleaner if one is fitted, otherwise where the air enters the engine or carburettor. The thermometer bulb shall be shielded from direct exhaust radiation.

9.5 Presentation of power curves. For the initial and final power tests, curves of power output, crankshaft torque, fuel consumption and specific fuel consumption shall be drawn over the full range of engine speeds available. Fuel consumption shall be indicated in terms of volume/time or mass/time. Specific fuel consumption shall be indicated on a basis of the observed values of fuel consumption and brake power.

9.6 Determination of maximum sustained power. The maximum brake load which the engine can sustain at the rated speed shall be applied for 2 hours. Where no governor is fitted, the test shall be carried out under full throttle.

Not less than 6 power readings shall be taken at equal intervals during the 2 hour test period.

The maximum sustained power stated in the test report shall be the average of the readings made during the 2 hour period. If the power variation exceeds $\pm 10\%$ from the average the test shall be repeated. If the variation continues the deviation shall be stated in the report.

9.7 Presentation of results. Typical curves shall be presented as shown in Appendix B. The results shall also be given in tabular form as shown in Appendix A.