UNITED NATIONS
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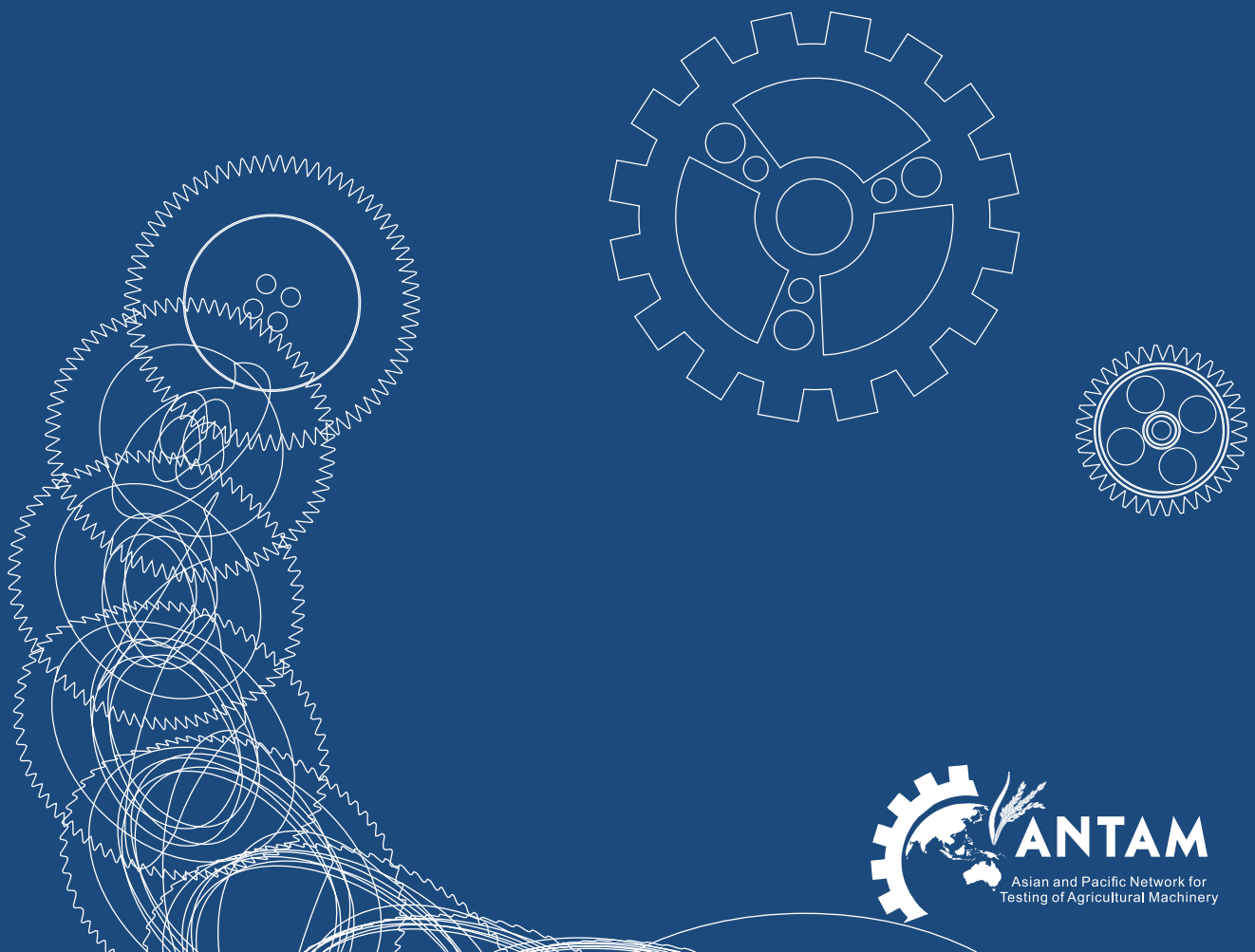
Economic and Social Commission for Asia and the Pacific

CSAM

ANTAM STANDARD CODE FOR TESTING OF POWER TILLERS

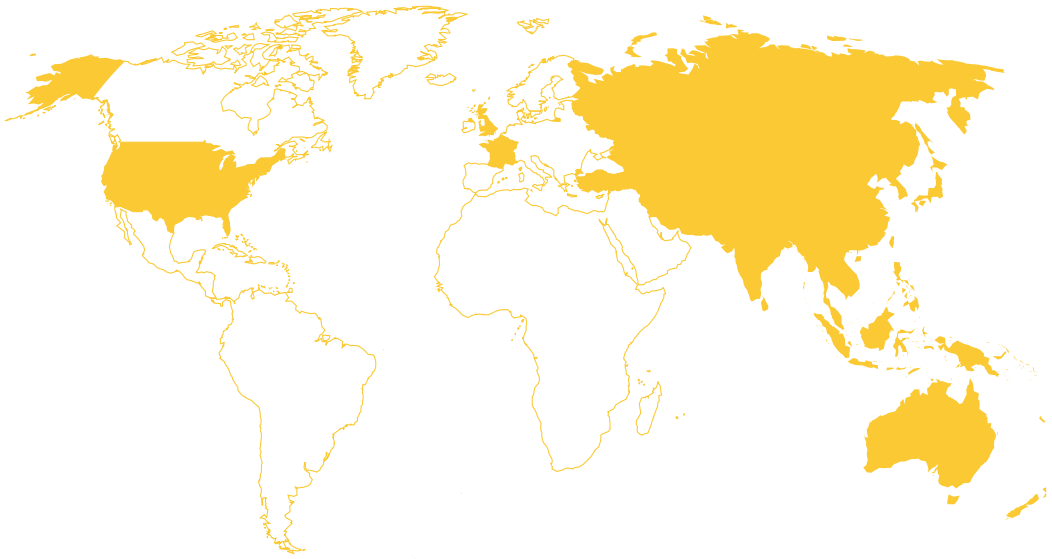


ANTAM
Asian and Pacific Network for Testing of Agricultural Machinery

The Centre for Sustainable Agricultural Mechanization (CSAM), is a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), based in Beijing, China. CSAM started operations in 2004, building on the achievements of the Regional Network for Agricultural Machinery (RNAM) and the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM). CSAM serves the 62 members and associate members of UNESCAP.

The vision of CSAM is to achieve production gains, improved rural livelihood and poverty alleviation through sustainable agricultural mechanization for a more resilient, inclusive and sustainable Asia and the Pacific.

The Secretariat of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM) is based at CSAM. CSAM is the executing agency of ANTAM. The ANTAM Secretariat assists and coordinates the operation of the network, and provides necessary logistical and administrative support.



The shaded areas of the map indicate ESCAP members and associate members

ANTAM STANDARD CODE
FOR TESTING OF POWER TILLERS

Centre for Sustainable Agricultural Mechanization
The United Nations Economic and Social Commission for Asia and the Pacific

001-2016

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Acknowledgments

The ANTAM Test Code on Power Tillers was prepared under the supervision of the Centre for Sustainable Agricultural Mechanization of the United Nations Economic and Social Commission for Asia and the Pacific (CSAM-ESCAP). The current version of the Code is based on the first edition published in August 2015, initially drafted by Dr. Chan Chee Wan and modified based on technical negotiations conducted in 2015.

The consultation process in 2016 started in March and was concluded at the 2nd Meeting of ANTAM Technical Working Groups held on 10-13 May in Bangkok, Thailand, with contribution from Dr. Chandreshekhar R. Lohi, Dr. Israil Hossain, Mr. Chao Sinh, Mr. Chang Xiongbo, Dr. Shabbir Ahmed Kalwar, Mr. Darwin Aranguren, Mr. Pavel Ishkin and Dr. Anuchit Chamsing. Comments were also received from Dr. Vadim Pronin, and Mr. Chakradhar Chimote. The ANTAM Test Code on Power Tillers was formulated by referring to relevant ISO and OECD standards and merged with relevant national standards from China, India, Indonesia, Philippines, and Thailand to reflect unique local conditions.

ANTAM Focal Points in China, India, and Thailand Ms. Han Xue, Dr. Alagusundaram, Dr. Singh and Mr. Vibbon Thepent provided support to the organization of ANTAM meetings in their respective countries. Mr. Wei Zhen, IT Specialist of CSAM, contributed to the layout design.

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I. Foreword

The Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM) is an initiative facilitated by the Center for Sustainable Agricultural Mechanization (CSAM) of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The network promotes regional standards to support the use of safe, efficient and environmentally sound agricultural machinery throughout Asia Pacific countries.

Farmer in the Asia Pacific region are progressively replacing animal power with agricultural machinery. For example, China's overall mechanization rate' raised from 35% in 2004 to 59% in 2013, while India's power availability has maintained steady growth rates from 0.92 Kw/ha in 1996 to 1.84 Kw/ha in 2012. South-east Asia countries such as Cambodia and Vietnam have doubled the agricultural horsepower during the first decade of the 2000s[1]. Nonetheless, only few countries engage in local manufacturing- the majority of countries rely on imports of machinery. Lack of harmonized testing standards limits the diffusion of mechanized agriculture and increases the price of the equipment for end users. The adoption of mutually recognized testing Codes would facilitate technological exchange and foster effective collaboration amongst machinery producers. The market is further constrained by the absence of a regional agreement on trade and agricultural machinery that results in expensive and lengthy procedures for imports and limits the number of players in each market. Finally, the fragmented market limits provision of after-sales services, including training on correct use of machinery.

Moreover, production practices in Asia Pacific are typically input intensive and have contributed to many of the environmental challenges, including climate change, that the regions is currently faced with. This calls for the coordinated efforts of all players in assuring that mechanization makes the best uses of national resources and limits emissions and use of chemicals. In this context, having a regional Code that applies international standards on emissions is a useful vehicle to monitor and control the environmental footprint of agriculture.

In line with the principles promoted by the Sustainable Development Goals, the ANTAM project promotes a transformative approach to development that integrates local needs with international standards and builds on public private partnerships to find solutions to cross sectoral developmental issues. The ANTAM Codes represent a unique regional effort in coordinating all players in the field of agricultural machinery. The writing and negotiation process involved representative from national governments, research and testing institutes, private sector and manufacturers.

The ANTAM Codes for testing of agricultural machinery are established by appointed members of the Technical Working Groups (Appendix 2) based on national standards of ESCAP member countries and major international requirements for agricultural machinery testing. The first version of the ANTAM Code for Power Tillers was published in August 2015 developed through several rounds of technical consultation with experts from nine participating countries. The second version of the ANTAM Code for Testing of Power Tillers (2016) is enriched with three more tests i.e. rotary shaft performance, vibration level and waterproof ability, to better reflect the agricultural needs of participating countries and assure an enhanced level of safety and performance.

[1] FAO-RAP (2014) Report of the High Level Multi-Stakeholder Consultation on Sustainable Agricultural Mechanization Strategy [SAMS] for the Asia and the Pacific Region convened by FAO & UNESCAP/ CSAM; Bangkok, 26-27 June 2014. FAO-RAP, Bangkok, Thailand.

II. Method of Operation[2]

The Annual Meeting shall adopt the Test Codes by consensus of participating countries.

The Technical Working Groups (TWGs) of ANTAM develop, review and revise ANTAM Codes based on the decision adopted at the Annual Meeting of ANTAM.

The ANTAM Test Codes are updated yearly by the TWGs through several rounds of technical negotiations. The content of the Codes is finalized and agreed upon by consensus of all TWGs members at the annual meetings of the TWGs.

The ANTAM Test Code on Power Tillers was formulated by referring to relevant ISO and OECD standards and merged with relevant national standards from China, India, Indonesia, Philippines, and Thailand. As specified in the Terms of Reference of the TWGs, members are responsible for selecting and providing relevant references to national and international standards. All selected standards are subject to revision and considered the most updated edition as per documents provided by TWGs members. All documents provided from national standards agency are copyrighted.

Implementation of ANTAM Test Codes is voluntary. Member countries can use ANTAM Test Codes in their entirety or refer to parts of the Code to integrate procedures applied in national testing stations. ANTAM Test Codes apply only to the equipment described in the Codes. Thus, any testing station from an ANTAM member country is welcome to use the test Codes assuming it has adapted testing equipment, facilities and skilled personnel.

Participating national testing stations are responsible for using the Codes to carry out the tests and fill the test report. Each testing station shall certify that ANTAM Codes are followed and that the test report complies with ANTAM Test Codes and procedures. ANTAM strongly encourages the implementation of round robin tests[3] among testing stations in order to insure that test reports are supported by a quality assurance process.

The test report shall be verified by the ANTAM Secretariat prior to its release. The ANTAM Secretariat shall work with the Technical Reference Unit (TRU), an independent third party, elected by member countries at the Annual Meeting, to check the technical contents of the report to ensure strict compliance.

Upon approval and validation by the ANTAM Secretariat, ANTAM logo shall be used on the tested machinery. The ANTAM Secretariat will then release the test report on its website.

The ANTAM Test Codes are designed to guide member countries in the application of standards for testing of agricultural machinery. The Codes provide information only and do not constitute formal legal advice. The ANTAM Secretariat assumes no liability for actions undertaken in reliance on the information contained in the Codes.

[2] In reference to the Terms of Reference of ANTAM adopted by the Annual Meeting on December 4, 2015 and the first edition of ANTAM Codes published in August 2015 (available at: http://www.antam-network.net/2016/category/publication/antam-codes)

[3] Measurement system analysis technique, where independent technicians perform the tests in different stations. The interlaboratory activity is encouraged to compare discrepancies in results and determine the reproducibility of test methods.

III. General Text

1.0 SCOPE

This standard covers the terminology, general guidelines and tests to be conducted on power tillers. It also covers methodology for checking on machine specifications, engine performance, rotary shaft performance, vibration level, drawbar performance, turning ability, parking brake ability, noise measurement at operator's ear level and waterproof ability.

The tests conducted for establishing performance characteristics of power tillers that are ready for commercial production or already in production.

This publication supersedes the previous ANTAM Standard Code for testing of Power Tillers (2015). This Code is subject to revision.

2.0 REFERENCES

The standards listed in **Annex A** contain provisions which through reference in this text, constitute provision of this Code incorporating existing national standards practiced by ISO, OECD, and China, India, Indonesia, Philippines and Thailand.

3.0 TERMINOLOGY

3.1 Power Tiller

Power tiller is a single axle, self-powered and self-propelled tractor, which can pull and power various farm implements such as rotary, cultivator, harrow, plough, seeder, harvester, and trailer.

3.1.1 General Purpose Type

The power tiller which can be used for a number of farm operations, including the types defined under pull type and tilling type.

3.1.2 Pull Type

The power tiller which pulls various kind of implements.

3.1.3 Tilling Type

The power tiller which uses an engine power driven tilling device, such as rotary and crank or screw blades.

3.2 Maximum Engine Power

Maximum sustainable engine power available at the crankshaft.

3.3 Operational Mass

The mass of the power tiller without operator in normal working condition with fuel tank and radiator (if fitted) full and lubricants filled to the specified levels.

Note: Any accessory fitted and its mass should be stated.

3.4 Rated Engine Power

The power available at the crankshaft or its equivalent at the rated speed specified by the manufacturer.

3.5 Tyre Rolling Radius

The effective radius corresponding to the average distance travelled by the power tiller in one rotation of the driving wheels (that is, this distance divided by 2π). When the power tiller is driven without drawbar load at a speed of approximately 2 km/h.

3.6 Wheel Slip (for dry land operation)

This shall be determined by the following formula:

Where $$Slip, percent = \frac{100\ (N_1 - N_2)}{N_1}$$

N_1 = Sum of revolutions of driving wheels for a given distance (at least 20 m) when the power tiller is driven under load, and
N_2 = Sum of revolutions of driving wheels for the same distance when the power tiller is driven without load at a speed approximately 2.0 km/h

4.0 GENERAL GUIDELINES

4.1 Conditions for Checking of Dimensions

4.1.1 The power tiller shall be without any wear on tyres and placed on a firm horizontal surface (4.2.1 IS 9935-2002). A minimum tyre tread bar height of 65 percent versus new tyre is not accepted (9.2.6 GB/T 6229-2007).

4.1.2 Unless otherwise stated by the manufacturer/applicant, the power tiller shall be stationary with its wheels and components in the positions they would be, if the power tiller was travelling in a straight line (4.2.2 IS 9935-2002).

4.1.3 The pressure in pneumatic tyres shall be adjusted to the value recommended by the power tiller manufacturer for field work (4.2.3 IS 9935-2002). If a range of value is indicated the mean tyre pressure shall be used (3.3.3 GB/T 6229-2007).

4.2 Running-In

The manufacturer/applicant shall run-in the power tiller before the test, under his responsibility and in accordance with his usual instructions. The running-in shall be carried out in collaboration with the testing authority. If this procedure is impracticable due to the power tiller being an imported model, the testing authority may itself run-in the power tiller in accordance with the procedure prescribed or agreed to with the manufacturer/applicant.

4.2.1 The place and duration of the running-in shall be reported in the pro-forma given in **Annex C**.

4.3 Servicing and Preliminary Setting after Running-In

4.3.1 After completion of running-in, servicing and preliminary settings should be done according to the printed literature supplied by the manufacturer/applicant. The following may be carried out, wherever applicable:

a) Change of the engine oil;
b) Change of air cleaner oil (if provided with an oil bath type air cleaner);
c) Change of transmission oil;
d) Change of oil and fuel filters (if required);
e) Greasing/oiling of all the lubricating points;
f) Adjustment of valve clearance and injection pressure (if required);
g) Tightening the nuts and bolts;
h) Checking and adjusting the tension of belts and chains;
i) Checking and adjustment of safety devices, if any;
j) Any other checking or adjustment recommended by the manufacturer after the running-in period, and included in the printed literature of the power tiller.

4.3.2 The manufacturer/applicant may make adjustments in fuel injection pump, governor, fuel injector and any other adjustments during the period the power tiller is prepared for tests. These adjustments should conform to the values specified by the manufacturer/applicant for agricultural use in the printed literature/specification sheet. No adjustment shall be made, unless it is recommended in the literature. All the parts replaced shall be reported in the test report.

Note: Adjustment of fuel injection pumps except for low/high idling speed shall not be permitted under test.

4.4 Ballasting

The ballast mass, which are commercially available and approved by the manufacturer for use in agriculture, may be fitted. For wheeled power tillers, liquid ballast on each tyre including liquid ballast in the tyres, and the inflation pressures shall be within the limits specified by the tyre manufacturer or load limit of axle, whichever is lower. Measure inflation pressure with the tyre/tube valve in the possible lowest position.

4.5 Repairs and Adjustments during Tests

All repairs and adjustments made during the tests shall be reported, together with comments on any practical defects or shortcomings in **Annex C**. This shall not include those maintenance jobs and adjustments which are performed in conformity with the

manufacturer's recommendations.

4.6 Fuel and Lubricants

Fuel and lubricants for the tests shall conform to the printed literature supplied by the manufacturer (5.3 IS 12226: 1995 and JB/T 7282- 2004).

4.7 Auxiliary Equipments

For all power tests, accessories/ auxiliary drives (if any) may be disconnected only if it is practicable to do so as a normal practice during work in accordance with the operator's manual without using any tool. If not, they shall remain connected and operate at minimum load.

4.8 Fuel Consumption

The fuel measurement apparatus shall be so arranged that the fuel pressure at the fuel transfer pump is equivalent to that which exists when the power tiller fuel tank is half full. The fuel temperature shall be comparable to that in the normal operation of the power tiller when fuel is taken from the power tiller fuel tank. Efforts shall be made to limit the temperature variations throughout the tests.

4.8.1 To obtain hourly fuel consumption by volume and the work performed per unit volume of fuel, conversion of unit of mass to unit of volume shall be made using the density value at 15 ℃ (IS 9935:2002).

4.8.2 When the fuel consumption is measured by volume, the specific fuel consumption shall be calculated using the density corresponding to the appropriate fuel temperature.

4.9 Atmospheric Conditions

4.9.1 Atmospheric Pressure

Minimum 96.6 kPa during laboratory tests (5.2.3 GB/T 6229-2007). The pressure shall be noted at the beginning of the test.

4.9.2 Temperature

For power tests, the normal ambient temperature shall be 27$\pm$7 ℃ (5.2.3 GB/T 6229-2007). Ambient air temperature at a representative point shall be measured as follows: Approximately 2 m in front or side depending upon the location of suction or blower device of power tiller and approximately 1 m above the ground (IS 9935:2002).

Note: No correction shall be made to the test results for atmospheric conditions.

1.0 Measuring Tolerances

The measuring apparatus shall be such that the following items shall have the tolerances within the limits shown against each (4.1.2 GB/T 6229-2007):

a) Rotational speeds, rpm	± 0.5 percent
b) Time, s	± 0.2 s
c) Distance, m or mm	± 0.5 percent
d) Force, N and torque, N·m	± 1.0 percent
e) Acceleration, m/s^2	+ 1.0 percent
f) Mass, kg	± 0.5 percent
g) Atmospheric pressure, kPa	± 0.2 kPa
h) Tyre pressure, kPa	± 5 percent
i) Temperature of fuels etc, ℃	± 2 ℃
j) Wet and dry bulb thermometers, ℃	+ 0.5 ℃
k) Fuel consumption (overall for the apparatus used): 1) Engine test, kg 2) Rotary shaft test, kg 3) Drawbar test, kg	 + 1.0 percent + 1.0 percent + 2.0 percent
l) Angle, degree	+ 0.5 degree

IV. Code

Tests to be conducted on a power tiller are given below: checking of the specification, engine performance, rotary shaft performance, vibration measurement, drawbar performance, turning ability, parking brake test, noise measurement at operator's ear level and waterproof test.

1.0 CHECKING OF SPECIFICATIONS

1.1 Specification Sheet

1.1.1 The power tiller manufacturer/applicant shall supply the specifications of the power tiller consisting of the items listed in the specimen report given in **Annex B**, as well as any other information required by the testing authority to carry out the tests. The manufacturer/ applicant shall also supply technical literature such as operation, maintenance and service manuals, and parts catalogue (4.1 IS 9935: 2002).

1.1.2 The information given by the manufacturer/applicant in the specification sheet (Clause 1.1.1) shall be verified by the testing authority and reported. Details of the components and assemblies which do not conform to the relevant ANTAM Codes shall also be reported. The adequacy or otherwise of the literature shall be indicated (7.1 IS 9935: 2002).

1.2 Conditions for Checking of Dimensions

1.2.1 While checking the dimensions of the power tiller, the conditions laid down in 4.1 of the general guidelines shall be followed.

2.0 ENGINE PERFORMANCE TEST

2.1 General

The various tests shall normally be carried out continuously.

The angle of the connection of the shaft connecting the crankshaft to the dynamometer shall not exceed 2^0 (5.2.2 GB/T 6229-2007).

If an exhaust gas discharge device for the test area is used, it shall not change the engine performance.

The governor control shall be set for maximum power.

2.2 Natural Ambient Test

Make no corrections to the measured values of torque or power for atmospheric conditions or other factors. The atmospheric pressure shall not be less than 96.6 kPa. If this is not possible because of altitude, a modified carburetor or fuel pump setting may have to be used, the details of which shall be included in the report. The surrounding temperature shall be $27 \pm 7\ ^0$C (5.2.3 GB/T 6229-2007).

The following tests on the engine shall be conducted:

2.2.1 Maximum Power Test

Operate the engine at the speed where maximum power occurs for a period of 2 hours subsequent to a warming-up period to reach stabilized running conditions. Measure the power, torque and fuel consumption (6.1.2 IS 12036: 1995 and 5.3.1 GB/T 6229-2007).

The maximum power quoted in the test report shall be the average of at least six readings made at regular intervals during the 2 hour period. If the power varies by more than ±2 percent from the average, repeat the test. If the variation continues, report the deviation (5.3.1 GB/T 6229-2007).

2.2.2 Power at Rated Engine Speed

If maximum power does not occur at rated engine speed, an optional additional 1 hour test shall be carried out using the procedure stated in 2.2.1.

2.2.3 Varying Speed at Full Load

Measure the power, torque and fuel consumption as a function of speed at full power. Minimum 6 readings shall be taken between rated rpm and speed at maximum torque. The minimum speeds at which measurements are made shall be at the speed of maximum torque and, if possible, 15 percent below that speed (6.1.3 IS 12036: 1995 and 5.3.2 GB/T 6229-2007).

2.2.4 Varying Loads Tests

Measure the power, speed and fuel consumption at the values listed below of torque with the governor control set for maximum power at the rated engine speed (5.3.3 GB/T 6229-2007).

a) The torque corresponding to maximum power available at rated engine 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);
f) Unloaded [with the dynamometer disconnected if the residual torque is greater than 5 percent of the torque defined in (b)].

2.2.5 Five Hours Engine Rating Test

The engine shall be run continuously for 5 hours. For the first 4 hours, the engine shall be run at 90 percent of load (torque) corresponding to maximum power (IS 12036: 1995). During the 5th hour, the engine shall be run at a load corresponding to maximum power. During the test, all the parameters specified in 2.2.1 of this standard shall be recorded after every half-an-hour during the first 4 hours and after every 15 minutes during the 5th hour (6.1.7 IS 12036: 1995).

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 power tiller, depending upon the location of the suction or blower device on the power tiller and approximately 1.0 m above the ground;
- Atmospheric pressure;

- Relative air humidity;
- Air temperature at the engine air intake;
- Maximum coolant temperature (in the case of an air cooled engine, measure the temperature of the cylinder block at representative points);
- The fuel temperature at the inlet to the injection pump;
- Engine oil temperature;
- Exhaust gas temperature.

2.2.6 Presentation of Results

The data in 2.2.1 to 2.2.5 shall be reported in tabular form for each test condition (Annex D-6). If also presented in graphical form (which is optional), the following, covering the full range of engine speeds tested, shall be included:

a) Power as a function of speed;
b) Torque as a function of speed;
c) Fuel consumption (mass) and specific fuel consumption (mass) as a function of speed;
d) Specific fuel consumption (mass) as a function of power;
e) Report the no-load maximum engine speed.

3. ROTARY SHAFT PERFORMANCE TEST

3.1 General

The following tests will be conducted on rotary shaft at the lowest rotary shaft speed if there are more than one rotary shaft speeds available.

3.1.1 Natural Ambient Temperature Test

During the test the surrounding temperature will be within the range of $27 \pm 7\ ^{o}C$.

3.1.2 Varying Speed Test

Measure the power, torque and fuel consumption as a function of speed at full governor at approximately 1-2 percent speed increments. Readings shall be taken between no load rpm and speed at maximum torque (maximum power, rated power, maximum torque readings shall be taken). The minimum speeds at which measurements are made will be at the speed of maximum torque and, if possible, 15 percent below that speed (IS 9935:2002).

3.1.3 Five Hour Test at Rated Power of Rotary Shaft

The rotary shaft shall be run at 90 percent of load (torque) corresponding to maximum power continuously for 4 hours. During the 5^{th} hour, the engine shall be run at a load corresponding to maximum power. During the test the power, torque and fuel consumption will be reported after every half-an-hour during the first 4 hours and after every15 minutes during the 5^{th} hour (IS 9935:2002).

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 power tiller, depending upon the location of the suction or blower device on the power tiller and approximately 1.0 m above the ground;
- Atmospheric pressure;
- Relative air humidity;

- Air temperature at the engine air intake;
- Maximum coolant temperature (in the case of an air cooled engine, measure the temperature of the cylinder block at representative points);
- The fuel temperature at the inlet to the injection pump;
- Engine oil temperature;
- Exhaust gas temperature.

NOTE - If the engine speed recommended for field tests is different from rated engine speed, then tests at the recommended speed setting shall also be conducted.

The data will be recorded in Annex D-7.

4. VIBRATION MEASUREMENT TEST

4.1 The acceleration of mechanical vibration of components/assemblies of the power tiller shall be measured with the help of suitable vibration measuring device on the components listed in Annex D-8 (IS 9935:2002).

4.2 The power tiller shall be parked on a level concrete surface and tyres inflated according to off field pressure recommended for road work. The power tiller and its rotary tiller attachment (if recommended by manufacturer) shall be operated at rated engine speed at no-load (IS 9935:2002).

4.3 The data shall be recorded in accordance with Annex D-8.

5.0 DRAWBAR PERFORMANCE TEST

5.1 General

5.1.1 The power tiller shall be fitted with pneumatic wheels and the test shall be conducted on a clean, horizontal and dry concrete test track containing a minimum number of joints (IS 993:2002).

The test shall be conducted in running state corresponding to the manufacturer's recommendations.

5.1.2 During the test at drawbar, the governor control shall be set for maximum power at rated engine speed defined by the test (4.4.1.7 OECD Code 2-2014).

5.1.3 The test shall not be conducted in the gear for which the forward speed exceeds the safety limit of the testing equipment.

5.1.4 The test shall be made at least in the speeds, from one giving a travel speed immediately faster than in the gear in which the greatest maximum power is developed down to one immediately slower than the gear setting allowing maximum pull to be developed (4.4.1.7 OECD Code 2-2014).

5.1.5 During the test, the line of pull shall be maintained horizontal. The height of the drawbar shall remain fixed in relation to the power tiller.

5.1.6 At the beginning of the test, the height of the tyre tread bars shall not be less than 65 percent of their height when new. The measurement shall be made at the centre line of the standard tyres (9.2.6 GB/T 6229-2007).

5.1.7 The measurement of drawbar pull, speed and slip shall be started only after the operational conditions are stabilized.

5.1.8 The test shall be conducted for at least 20 m continuously without varying atmospheric or track conditions significantly (9.2.8 GB/T 6229-2007).

5.2 Test for Maximum Power and Pull

The test shall be conducted until the maximum power and pull are found in different forward speed gears. Measurement of engine speed, drawbar pull, fuel consumption, forward speed and wheel slip shall be recorded (9.3.1 GB/T 6229-2007).

The maximum drawbar pull and drawbar power shall be recorded at power tiller wheel slippage only up to 15 percent. As the no-slip distance will vary according to the degree of wear of the tyres, it will be necessary to check this regularly, particularly before determining maximum drawbar power (9.3.1 GB/T 6229-2007).

If the manufacturer/applicant recommends ballasting of the power tiller, the test shall be conducted both at ballasted and unballasted condition of the power tiller and the results shall be reported separately.

5.3 The data shall be recorded in D-3 and D-9.

6.0 TURNING ABILITY (GB/T 6229-2007 and IS 9935: 2002)

6.1 General

6.1.1 The test area shall be a horizontal compacted or paved surface having good tyre adhesion and capable of displaying legible marking.

6.1.2 The power tiller shall be tested with all liquid reservoirs filled to the specified level but without ballast, mounted implements and any other specified components.

6.1.3 At the beginning of the test, the height of the tyre tread bars shall not be less than 65 percent of their height when new. The inflation pressure in the tyres shall be maintained as recommended for the road work by the manufacturer.

6.1.4 The test shall be conducted with the power tiller without tailed wheel at the minimum attainable speed. The measurement of the turning circle and turning space are referred in figure 4a.

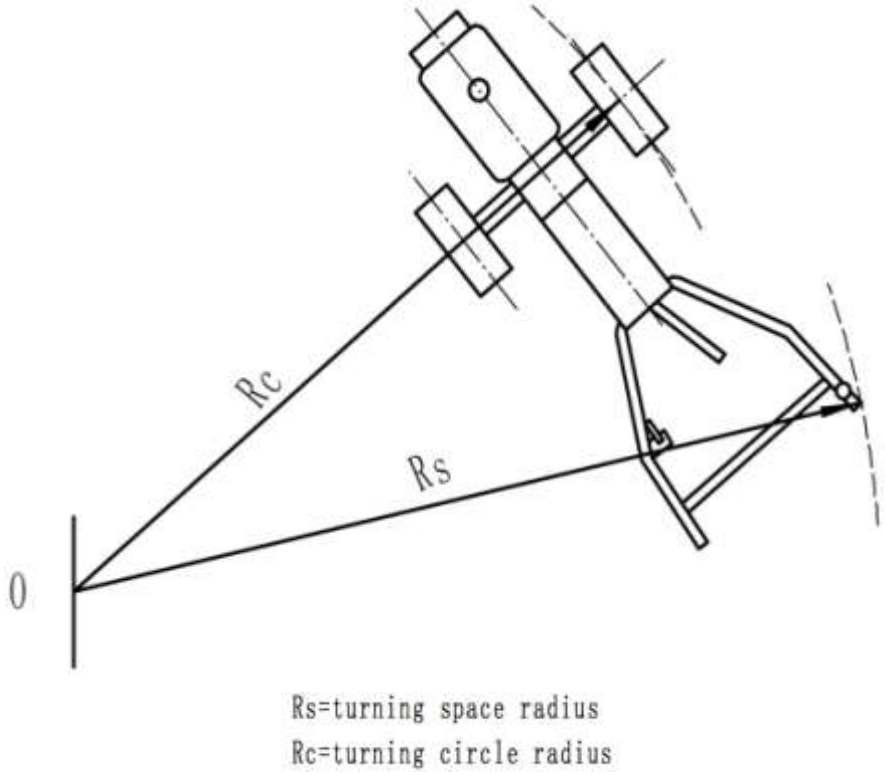

Figure 4a: The measurement of radius of turning circle and turning space
(6.3.1 GB/T 6229-2007)

6.2 Procedure

The test shall be carried out, using minimum travel speed, on the power tiller by turning it to the right and the left side by the use of steering clutch till a 360 degree turn is completed. During the test the following shall be recorded:

a) Diameter of the minimum turning circle, and
b) Diameter of the minimum turning space required.

6.3 The data shall be recorded in D-4.

7.0 PARKING BRAKE TEST

7.1 General

7.1.1 The performance of the parking brake shall be based on the ability to hold the power tiller stationary, facing up and down slopes.

7.1.2 The power tiller shall be attached with any matching implement e.g. rotary, plough etc. and without ballast.

7.1.3 The test shall be conducted on a clean, flat and dry concrete test track.

7.2 Procedure

7.2.1 The power tiller shall be placed out of gear on a slope of not less than 18 percent with the brakes applied. The power tiller shall be placed first facing up and then down the slope, the rotation of the braked wheel shall be observed. The observation along with the factors allowing the rotation of the wheels shall be stated in the test report (IS 9935: 2002).

The force, necessary to apply at the control of the parking braking device to hold the power tiller stationary when facing up and down shall be measured.

7.2.2 The data shall be recorded in Annex D-5.

8.0 NOISE MEASUREMENT TEST (IS 12180 (Part 1): 2000)

8.1 General

8.1.1 The noise measurement test shall be conducted at the operator's ear level during the drawbar pull test.

8.1.2 Sound level meter which meets at least the requirements of IEC 651- 1979 for a type 1 instrument shall be used.

8.1.3 The noise shall be measured with instrument of A weighted expressed in decibels set on slow level.

8.1.4 The test area shall be a flat open space and shall be within at least 20 m of the test machine. There shall be no obstacle likely to reflect significant sound, such as building, solid fence, tree or other vehicle.

8.1.5 The air temperature shall be in the range from -5 ℃ to 35 ℃ and the wind velocity shall not exceed 5 m/s at the operator's position (9.2.4 GB/T 6229-2007).

8.1.6 For seated operators, the microphone shall be located 250 mm ± 20 mm to the side of the center plane of the seat, the side being that on which the higher sound pressure level is encountered. The axis of the microphone shall be horizontal and the diaphragm shall face forwards. The centre of the microphone shall be 700 mm ± 20 mm above the seat index point and 100 mm ±20 mm forward of that point. Excessive vibration of the microphone shall be avoided. The seat index point shall be determined in accordance with ISO 5353: 1995.

8.2 Procedure

8.2.1 The test shall be conducted at different drawbar loads in different forward speed gears. The drawbar loads shall be applied by the loading device remotely positioned to eliminate interference with the sound fields caused by the power tiller.

8.2.2 During the measurement, the microphone shall be horizontal and facing forward. It shall be 5 cm to the side of the operator's forehead and in line with his eyebrows. It shall be mounted on an open frame helmet.

8.2.3 The sound level measurements shall be made in all forward speed gears under safety test condition. The results shall be reported in the gear giving the nearest forward speed of 2km/h and also under any gear for which a sound level of at least 1 dB (A) above that of the above

mentioned gear was recorded.

8.2.4 The data shall be recorded in Annex D-10.

9. WATERPROOF TEST

9.1 General

9.1.1 The waterproof test is conducted to determine the effectiveness of the seals of the power tiller when operated under lowland condition.

9.1.2 The power tiller shall be fitted with puddling wheels as per recommendation of manufacturer and with no implement attached.

9.1.3 The power tiller is classed as "waterproof power tiller," if after the test described below, there is no soil and water penetration into axle, brake and clutch system (4.9.1 OECD Code 2).

9.2 Test Conditions

9.2.1 Test Bed

9.2.1.1 The test shall be conducted in a testing water bath/soil bin filled with a mixture of soil and water with a ratio of 1:3 by volume (TIS 1350-1996).

9.2.1.2 The soil shall contain 10-30% sand, 10-30% silt and 40-80% clay by weight while potable water shall be used (TIS 1350-1996).

9.2.2 Soil Mixture /Water Level

9.2.2.1 The soil mixture /water level shall be adjusted to the height of the centre line of the wheel axle with the power tiller in a horizontal position.

9.2.2.2 The power tiller shall be installed and fixed on a stand for free rotation of puddling wheels.

9.3 Test Procedures

9.3.1. General Provisions

9.3.1.1 The power tiller shall be in the gear giving the nominal forward speed nearest to 6 kmph (4.9.3.1 OECD Code 2) and operated continuously at rated engine speed for 5 hours.

9.3.1.2 If there will be leakage of oil from the axle shaft to the mixture of soil and water prior to the completion of test, then the test shall be terminated.

9.3.1.3 The power tiller shall then be removed from the testing bath and be cleaned.

9.3.1.4 The power tiller shall be left in a place free from rain or snow for at least 12 hours before being finally checked (4.9.3.1 OECD Code 2).

9.3.1.5 The axle, clutch housing, the brake assembly shall then be disassembled and any evidence of soil and water solution penetration into them shall be stated in the test report.

9.3.2 Unsuccessful Test

If the test fails, the manufacturer may ask for a repeat test of the same power tiller but only once. The power tiller when re-tested shall be equipped with the same components after the seals have been changed and/or re-fixed in conformity with manufacturer's specifications (4.9.3.1 OECD Code 2).

9.3.3 Checking Methods for Ingress of Water/Mud in the Oil

The oil in the housing (e. g. transmission box, engine sump) shall be checked using one or more of the following alternative methods (4.9.3.1 OECD Code 2):

9.3.3.1 Visual method: Distinct emulsification and/or colour change of the oil shall be regarded as proof of water ingress or;

9.3.3.2 Crackling method: When water ingress is not visually distinct, the presence of water in the lubricant shall be checked by putting a heated electric soldering iron into the oil. The presence of water crackling shall be regarded as waterproof failure; conversely, no crackling shall be regarded as waterproofing; or

9.3.3.3 Other methods: Other physical (e.g. centrifugation) or chemical (e.g. Karl-Fisher) standards to check if there is water in the oil are accepted.

9.3.4 The data shall be recorded in Annex D-11.

V. Annexes

ANNEX A

LIST OF CITED STANDARDS

Standards No.	Title
GB/T 6229-2007	Test Methods for Walking Tractors
IEC 651-1979	Sound Level Meters
IS 12036:1995	Agricultural Tractors-Test Procedures-Power Test for Power Take-off
IS 12180-1:2000	Tractors and Machinery For Agriculture and Forestry -- Noise Measurement- Method of Test: Part: 1: Noise at the Operator's Position - Survey Method
IS 12226:1995	Agricultural Tractors -- Power Tests for Drawbar -Test Procedure (First Revision)
IS 9935:2002	Power Tiller -- Test Codes
ISO 4251-1:2005	Tyres (Ply Rating Marked Series) and Rims for Agricultural Tractors and Machines -- Part 1: Tyre Designation and Dimensions, and Approved Rim Contour
ISO 5353:1995	Earth-Moving Machinery and Tractors and Machinery for Agriculture and Forestry -- Seat Index Point
JB/T 7282-2004	Types and Specifications of Oils for Tractors
OECD Code 2-2014	OECD Standard Code for the Official Testing of Agricultural and Forestry Tractor Performance
PNS/PAES 117:2000	Agricultural Machinery-- Small Engine- Method of Test
SNI 0738:2014	Quality Standard and Testing Method of Two-wheel Tractors
TIS 1350-1996	Walk-behind tractors
TIS 787-2008	Small size water cooled diesel engines

***** *IS = Indian Standards*

GB/T and JB/T = Chinese Standards

IEC = International Electrotechnical Commission

ISO = International Standard Organization

OECD = Organization for Economic Co-operation and Development

PNS/PAES = Philippines National Standard/Philippines Agricultural Engineering Standard

SNI = Standard National Indonesia

TIS = Thai Industrial Standard

ANNEX B[4]

(Clause 1.1.1)

SPECIFICATION SHEET FOR POWER TILLERS

B-1 POWER TILLER a) Name and address of the manufacturer: b) Name and address of the applicant for test: c) Type: d) Make/Model: e) Serial number: f) Year of manufacture: g) Net mass, kg:
B-2 ENGINE a) Type/Make/Model: b) Manufacturer: c) Serial number: d) Engine rated speed (recommended by manufacturer) : e) Power at rated speed, kW: f) Net mass, kg:
B-3 CYLINDERAND CYLINDER HEAD a) Configuration (vertical or horizontal): b) Bore/stroke, mm: c) Capacity, cm^3: d) Compression ratio: e) Type of combustion chamber:
B-4 FUEL SYSTEM a) Type of fuel b) Capacity of fuel tank, liters: c) Type of fuel filter: d) Manufacturer's production setting of fuel injectors (Valve opening pressure), kPa: e) Injection timing: f) Type of injection pump:
B-5 GOVERNOR a) Type: b) Governed range of engine speed, rpm: c) Rated engine speed, rpm:
B-6 AIR CLEANER a) Type (wet or dry) : b) Location of air intake (in case of no pre-cleaner) : c) Oil sump capacity, liter:
B-7 EXHAUST

[4] Annex B, C, D and E are developed in reference to IS 9935: 2002.

a) Type of silencer:
b) Location:

B-8 Oil sump capacity, liter:

B-9 COOLING SYSTEM

a) Type:
b) Details of pump and fan, if available:
c) Coolant capacity, liter:

B-10 ELECTRICAL SYSTEM

a) Voltage:
b) Output power of generator, kW:
c) Details of headlights (number, Watt):

B-11 POWER TRANSMISSION SYSTEM

a) Gearbox
1) Oil capacity, liters:
2) Number of gears
i) Forward:
ii) Reverse:
3) Nominal traveling speed at rated engine speed

	Gear number	Nominal traveling speed (*) at the rated engine speed of … rpm (km/h)
Forward	L1	
	L2	
	L3	
	H1	
	H2	
	H3	
Reverse	L1	
	H1	

** Calculated with a pneumatic tyre dynamic radius index of ..... mm (ISO 4251-1:2005)*

b) Type of main clutch:
c) Type of steering clutch:

B-12 ROTARY SHAFT (If applicable)

a) Location:
b) Number of splines:
c) Speed, rpm:
d) Diameter of shaft, mm:
e) Height above ground, mm:
f) Direction of rotation (viewed from driving end) :
g) Rotary shaft speed at rated engine speed, rpm:
h) Power transmission system
1) Sprocket and chain:
2) Any other:
i) Arrangement for fitting of tines on the shaft:
j) Number and type of tines:

B-13 MAIN PULLEY

a) Type and number of belts:
b) Diameter, mm:
c) Location:
d) Reduction ratio (from engine to clutch) :
e) Rotational speed at rated engine speed (rpm):

B-14 HITCH (If applicable)

a) Type (pin or nut and bolt):
b) Location:
c) Height above ground level, mm
  1) Maximum:
  2) Minimum:

B-15 PARKING BRAKE

a) Type:
b) Method of operation:

B-16 WHEEL

a) Tyres
  1) Make:
  2) Size:
  3) Type of tyre:
  4) Ply rating:
  5) Recommended inflation pressure, kPa
    i) For fieldwork:
    ii) For transport:
  6) Track width, mm:
  7) Method of changing track width, range and number of steps:
  8) Method of changing track width, if any, and range:
b) Steel wheel for wet land
  1) Track width, mm:
  2) Type:
  3) Size
    i) Diameter, mm:
    ii) Width, mm:
  4) Total mass (2 wheels), kg:
c) Tail wheel (if applicable)
  1) Steel wheel
    i) Diameter, mm:
    ii) Width, mm:
    iii) Mass, kg:
  2) Pneumatic tyre
    i) Type:
    ii) Tyre inflation, kPa:
    iii) Mass, kg:

B-17 OPERATOR'S SEAT FOR RIDING TYPE

a) Type:
b) Type of suspension:
c) Range of adjustment (if any), mm:

B-18 MASS OF BALLAST

Ballast Mass as Used, kg		
	Water	*Cast Iron Weight on -Wheel*

Optional ballast		
B-19 MASS OF POWER TILLER (WITHOUT DRIVER BUT WITH LUBRICANT, FUEL AND COOLANT FULL)		
	Ballast	Unballast
Total		

B-20 OVERALL DIMENTIONS (mm)				
Conditions	*Length**	*Width**	*Height**	*Ground Clearance*
With ballast				
Without ballast				
* *Measure the outermost points*				

ANNEX C

(Clause 4.2.1 and 4.5)

PROFORMA FOR SELECTION, RUNNING-IN AND REPAIRS

C-1 NAME OF THE MANUFACTURER

C-2 ADDRESS

C-3 SUBMITTED FOR TEST BY

C-4 SELECTED BY

C-5 PLACE OF RUNNING-IN

C-6 DURATION AND SCHEDULE OF RUNNING-IN

C-7 REPAIRS AND ADJUSTMENTS MADE DURING RUNNING-IN

C-8 NO. OF SEALING

C-9 LOCATION OF SEALING

ANNEX D

(Clause 2.2.1 to 2.2.5, 3, 4, 5, 6, 7, 8, 9)

DATA SHEET FOR LABORATORY AND TRACK TESTS OF POWER TILLER

D-1 POWER TEST

a) Date and place of test:
b) Type of dynamometer used:
c) Fuel used
  1) Type:
  2) Density at 15 ℃:
d) Engine oil used
  1) Type:
  2) Grade:
e) Transmission oil used:
f) No load maximum engine speed, rpm:
g) Engine performance test data sheet given in **D-6**:

D-2 ROTARY SHAFT TEST

a) Date and place of test:
b) Type of dynamometer used:
c) Fuel used
  1) Type:
  2) Density at 15 ℃:
d) Engine oil used
  l) Type:
  2) Grade:
e) Type of transmission oil used:
f) No load maximum engine speed, rpm:
g) Engine performance test data sheet given in **D-6**:

D-3 DRAWBAR PERFORMANCE TEST

a) Date and location of tests:
b) Type of track:
c) Height of drawbar point above ground:
d) Mass of power tiller, without ballast:
e)Type and size of tyres:
f) Tyre pressure, kPa:
g) Details of fuel used (fuel number and standard):
h) Test data (see D-8):

D-4 TURNING ABILITY

a) Details of wheels
  1) Wheel track, mm:
  2) Size of tyres:
  3) Pressure of tyres, kPa:
b) Test data

Description	*Minimum Turning Circle Diameter*		*Minimum Turning Space Diameter*	
	Right Hand Side (m)	*Left Hand Side (m)*	*Right Hand Side (m)*	*Left Hand Side (m)*

(1)	*(2)*	*(3)*	*(4)*	*(5)*
With Steering Clutch				

D-5 PARKING BRAKE TEST Power tiller mass, kg:		
Degree of slope (^{0}):		
Observations	*Parking Braking Device Facing up Slope*	*Parking Braking Device facing down Slope*
(1)	*(2)*	*(3)*
Parking device control force (N)		
Whether rolling of braking wheels noticed	*Yes/No*	*Yes/No*
Efficacy of brakes	*Yes/No*	*Yes/No*

D-6 ENGINE PERFORMANCE TEST DATA SHEET														
Test	Power (kW)	Crank Shaft Torque (Nm)	Engine Speed (rpm)	Fuel Consumption		Specific Energy (kWh/1)	Temperature, ^{0}C					Atmospheric Conditions		
				Hourly (kg/h)	Specific (g/kWh)		Fuel	Intake air	Engine oil	Coolant	Exhaust air	Temp (^{0}C)	Relative Humidity (%)	Pressure (kPa)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)Maximum power test														
ii) Power at rated engine speed														
Varying engine speed at full load i) ii) iii) iv) v) vi)														
Rated engine speed at varying load i) ii) iii) iv) v) vi)														

FIVE HOURS TEST												
Test	Power (kW)	Crank Shaft Torque (Nm)	Engine Speed (rpm)	Fuel Consumption		Specific Energy (kWh/1)	Temperature (^{0}C)			Atmospheric Conditions		
				Hourly (kg/h)	Specific (g/kWh)		Fuel	Engine oil	Coolant	Temp (^{0}C)	Relative Humidity (%)	Pressure (kPa)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Five hours engine rating test a) At load corresponding to 90% of maximum power (4 hour) i) ii) iii) etc.												
At load corresponding to maximum power i) ii) iii)												

D-7 ROTARY SHAFT PERFORMANCE TEST DATA SHEET

Sl. No.	Test Condition	Tests	Rotary Shaft Power	Rotary Shaft Torque	Engine Speed rpm	Fuel Consumption		Specific Energy	Temperature °C					Pressurre kPa			Atmospheric Conditions			Rotary Shaf Oil Temp
						Hourly	Specifi		Fuel	Engine Oil	Exhaust	Intake Ai	Coolant	Intake Ai	Exhaust Gas	Lub Oil	Temp °C	Relative Humidity %	Pressure kPa	°C
			kW	N.m		g/h	g/kWh	kWh/l												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
i)	Normal Ambient Test	Varying engine speed at full load i) ii) iii) etc																		
	same	Five hours test at rated power of rotary shaft a)At load corresponding to 90% of maximum power (4 hours): i) ii) iii) etc b) At load corresponding to maximum power i) ii) iii) etc																		

D-8 TEST DATA FOR VIBRATION MEASUREMENT

D-8.1 Date of test
D-8.2 Type of instrument
D-8.3 Location of test
D-8.4 Type of power tiller (tilling or pull)

S.No.	Measuring points		Vibration (Hz) Acceleration (m/s^2)	
(1)	(2)		(3)	
			HD	VD
1	Steering handle	Left arm grip		
		Right arm grip		
2	Operator's seat (without operator)			
3	At main frame where engine mounted			

* HD: Horizontal direction
VD: Vertical direction

D-9 TEST DATA DRAWBAR PERFORMANCE

Test	Gear Number Used	Travel Speed (km/h)	Drawbar Pull (kN)	Drawbar Power (kW)	Wheel Slip (%)	Engine Speed (rpm)	Fuel Consumption		Specific Energy (kWh/1)	Atmospheric Conditions		
							kg/h	g/kWh		Temperature (^{0}C)	Pressure (kPa)	Relative Humidity (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Maximum power test (power tiller un-blasted) i) ii) iii)												

D-10 DATA SHEET FOR NOISE MEASURAMENT

D-10.1 AT OPERATOR'S EAR LEVEL						
D-10.1.1 Brief Description of the Silencing System						
D-10.1.2 Background Noise Level, dB (A)						
D-10.3 Sound Level Meter Sound Level Meter 1) Type: 2) Make: 3) Model:						
D-10.4 Date of Test						
D-10.5 Atmospheric Conditions a) Temperature, ^{0}C b) Pressure, kPa c) Relative humidity, %						
D-10.6 Test Data						
No	*Gear Used*	*Travelling Speed (km/h)*	Engine Speed (rpm)	*Slip (%)*	*Drawbar Pull (kN)*	*Sound Level dB (A)*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
1						
2						
3						
4						
5						
6						

D-11 DATA SHEET FOR WATERPROOF TEST

Sr No.	Components	Ingress of Mud/Water
1	Axle	Yes/No
2	Clutch housing	Yes/No
3	Brake assembly	Yes/No

Appendix 1

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(As of August 2016)

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