

# TRAINING MANUAL FOR ANTAM STANDARD CODES FOR TESTING OF POWER TILLERS

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

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**Training Manual for ANTAM Standard Codes for  
Testing of Power Tillers**

**Centre for Sustainable Agricultural Mechanization**

**The United Nations Economic and Social Commission for Asia and the Pacific**

This training manual was put together by Mr. Chakradhar Chimote of the Central Farm Machinery Training and Testing Institute of India, a consultant contracted by the Centre for Sustainable Agricultural Mechanization (CSAM) and the China Agricultural Machinery Testing Centre (CAMTC), for the 1<sup>st</sup> Training of Trainers Programme on ANTAM Test Codes held in Najing, China from 23 to 27 June 2015. Contents of the training manual were prepared as per *ANTAM Standard Codes for Testing of Power Tillers* (Version 2015, hereinafter referred to as “ANTAM Codes”), developed at the 1<sup>st</sup> Technical Working Group (TWG) meeting of ANTAM held from 4 to 6 May 2015 in Serpong, Indonesia.

This manual is the first attempt towards realizing the TOR of ANTAM with the intention for future review. The training manual is aimed to facilitate testing stations to implement ANTAM Codes. The ANTAM Codes are a dynamic process where regular updates and reviews will be made by the TWG of ANTAM at its annual meetings based on demands from participating countries. The current ANTAM Codes will be submitted to the 2<sup>nd</sup> Annual Meeting of ANTAM for review and adoption in December 2015.

Where testing equipment provided by the facilitating testing station for the training was not in supply, slight modifications of ANTAM standard testing methodologies were made in order to demonstrate the procedure.

The training manual was prepared under the substantive direction and guidance of Ms. AI Yuxin, Programme Officer of CSAM in charge of ANTAM project. Valuable comments and suggestions were received from Mr. CHANG Xiongbo of CAMTC. Ms. Camilla Stelitano, individual contractor of CSAM, provided indispensable support to the editing, layout and coordination. Mr. WEI Zhen, IT Assistant of CSAM, contributed design of the cover page. Special thanks to Ms. HAN Xue and Ms. BAI Mengliang of CAMTC for facilitating communication.

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## PART ONE

### GENERAL TEXTS

#### 1.0 SCOPE

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

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

#### 2.0 REFERENCES

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

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.

#### 3.0 TERMINOLOGY

##### 3.1 Power Tiller

A prime mover having single axle in which the direction of travel and its control for field operation is performed by the operator walking behind it. It is also known as hand or walking tractor. Some of these may have riding arrangement.



##### 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 tanks 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  $2\pi$ ). 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

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

$N_1$  = 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 lug height of 65% versus new tire 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 tire pressure will be used (3.3.3 GB/T 6229-2007).

## Tyre Pressure Gauge



### 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, and
- 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 valve in the 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 and JB/T 7282).

#### **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 °C.

**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  $27 \pm 7$  °C (5.2.3 GB/T 6229-2007).

Ambient air temperature at a representative point shall be measured as follows: Approximately 2m in front or side depending upon the location of suction or blower device of power tiller and approximately 1.5m above the ground.

NOTE—No correction shall be made to the test results for atmospheric conditions.

### 5.0 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, rev/min	$\pm 0.5$ percent
(b)	Time	$\pm 0.2$ s
(c)	Distance, m or mm	$\pm 0.5$ percent
(d)	Force, N and torque, Nm	$\pm 1.0$ percent
(e)	Mass, kg	$\pm 0.5$ percent
(f)	Atmospheric pressure, kPa	$\pm 0.2$
(g)	Tyre pressure, kPa	$\pm 5$ percent
(h)	Temperature of fuel set c, °C	$\pm 2$
(i)	Angle, degree	+ 0.5
(j)	Wet and dry bulb thermometers, °C	+ 0.5
(k)	Fuel consumption (overall for the apparatus used);	
	(1) Engine test, kg	+ 1.0 percent
	(2) Drawbar test, kg	+ 2.0 percent

### 6.0 TESTS TO BE CONDUCTED ON A POWER TILLER ARE GIVEN BELOW:

- Checking of the specification,
- Engine performance,
- Drawbar performance,
- Turning ability,
- Parking brake and
- Noise measurement at operator's ear level.

## PART TWO

### CHECKING OF SPECIFICATIONS

- 1) The information given by the manufacturer/applicant in the specification sheet (Clause 1.1.1) shall be verified by the testing authority and reported.
- 2) Details of the components and assemblies which do not conform to the relevant ANTAM Standards shall also be reported.
- 3) The adequacy or otherwise of the literature shall be indicated (7.1 IS 9935-2002).
- 4) Specification checking / measurement (see Annex B below).
- 5) Park the power tiller after completion of checking / measurement.

#### Weighing Balance



**ANNEX B**  
(Clause 1.1.1)

**SPECIFICATION SHEET FOR POWER TILLERS**

<b>B-1 POWER TILLER</b>
a) Name and address of the manufacturer: <a href="#">check</a> b) Name and address of the applicant for test: <a href="#">check</a> c) Type: <a href="#">check</a> d) Make/Model: <a href="#">check</a> e) Serial number: <a href="#">check</a> f) Year of manufacture: <a href="#">check</a> g) Net mass, kg: <a href="#">measure</a>
<b>B-2 ENGINE</b>
a) Type/Make/Model: <a href="#">check</a> b) Manufacturer: <a href="#">check</a> c) Serial number: <a href="#">check</a> d) Engine rated speed (recommended by manufacturer) : <a href="#">applicant's declaration to be endorsed.</a> e) Power at rated speed, kW: <a href="#">applicant's declaration to be endorsed.</a> f) Net mass, kg: <a href="#">measure</a>
<b>B-3 CYLINDER AND CYLINDER HEAD</b>
a) Configuration (vertical or horizontal): <a href="#">check</a> b) Bore/stroke, mm: <a href="#">measure</a> c) Capacity, cm <sup>3</sup> : <a href="#">calculation = No. of cylinders x (πd<sup>2</sup>h/4)</a> d) Compression ratio: <a href="#">applicant's declaration to be endorsed.</a> e) Type of combustion chamber: <a href="#">check</a>
<b>B-4 FUEL SYSTEM</b>
a) Type of fuel: <a href="#">Diesel / Petrol or other to be specified</a> b) Capacity of fuel tank, liters: <a href="#">check</a> c) Type of fuel filter: <a href="#">check</a> d) Manufacturer's production setting of fuel injectors (Valve opening pressure), kPa: <a href="#">applicant's declaration to be endorsed.</a> e) Injection timing: <a href="#">applicant's declaration to be endorsed.</a> f) Type of injection pump: <a href="#">check</a>
<b>B-5 GOVERNOR</b>
a) Type: <a href="#">applicant's declaration to be endorsed.</a> b) Governed range of engine speed, rpm: <a href="#">applicant's declaration to be endorsed.</a> c) Rated engine speed, rpm: <a href="#">applicant's declaration to be endorsed.</a>
<b>B-6 AIR CLEANER</b>
a) Type (wet or dry): <a href="#">check</a> b) Location of air intake (in case of no pre-cleaner): <a href="#">check</a> c) Oil sump capacity, liter: <a href="#">check</a>
<b>B-7 EXHAUST</b>
a) Type of silencer: <a href="#">check</a> b) Location: <a href="#">check</a>
<b>B-8 Oil sump capacity, liter: <a href="#">check</a></b>
<b>B-9 COOLING SYSTEM</b>
a) Type: <a href="#">check</a> b) Details of pump and fan, if available: <a href="#">check &amp; measure</a>

c) Coolant capacity, liter: <a href="#">check</a>		
<b>B-10 ELECTRICAL SYSTEM</b>		
a) Voltage: <a href="#">applicant's declaration to be endorsed.</a>		
b) Output power of generator, kW: <a href="#">applicant's declaration to be endorsed.</a>		
c) Details of headlights (number, Watt): <a href="#">Check</a>		
<b>B-11 POWER TRANSMISSION SYSTEM</b>		
a) Gearbox		
1) Oil capacity, liters: <a href="#">measure</a>		
2) Number of gears		
i) Forward: <a href="#">check</a>		
ii) Reverse: <a href="#">check</a>		
3) Nominal traveling speed at rated engine speed		
	Gear Number	Nominal traveling speed (*) at the rated engine speed of ... rpm (km/h)
Forward	L1	<a href="#">Test</a>
	L2	<a href="#">Test</a>
	L3	<a href="#">Test</a>
	H1	<a href="#">Test</a>
	H2	<a href="#">Test</a>
	H3	<a href="#">Test</a>
Reverse	L1	<a href="#">Test</a>
	H1	<a href="#">Test</a>
* Calculated with a pneumatic tyre dynamic radius index of ..... mm (ISO 4251-1:2005)		
b) Type of main clutch: <a href="#">check</a>		
c) Type of steering clutch: <a href="#">check</a>		
<b>B-12 ROTARY SHAFT</b>		
a) Location: <a href="#">check</a>		
b) Number of splines: <a href="#">measure</a>		
c) Speed, rpm: <a href="#">measure</a>		
d) Diameter of shaft, mm: <a href="#">measure</a>		
e) Height above ground, mm: <a href="#">measure</a>		
f) Direction of rotation (viewed from driving end) : <a href="#">check</a>		
g) Rotary shaft speed at rated engine speed, rpm: <a href="#">measure</a>		
h) Power transmission system		
1) Sprocket and chain: <a href="#">check</a>		
2) Any other: <a href="#">check</a>		
i) Arrangement for fitting of tines on the shaft: <a href="#">check</a>		
j) Number and type of tines: <a href="#">Measure / check</a>		
<b>B-13 MAIN PULLEY</b>		
a) Type and number of belts: <a href="#">Check / measure</a>		
b) Diameter, mm: <a href="#">measure</a>		
c) Location: <a href="#">check</a>		
d) Reduction ratio (from engine to clutch) : <a href="#">measure</a>		
e) Rotational speed at rated engine speed (rpm): <a href="#">measure</a>		
<b>B-14 HITCH</b>		
a) Type (pin or nut and bolt): <a href="#">check</a>		
b) Location: <a href="#">check</a>		
c) Height above ground level, mm		
1) Maximum: <a href="#">measure</a>		
2) Minimum: <a href="#">measure</a>		

<b>B-15 PARKING BRAKE</b>				
a) Type: <a href="#">check</a>				
b) Method of operation: <a href="#">check</a>				
<b>B-16 WHEELS</b>				
a) Types				
1) Make: <a href="#">check</a>				
2) Number: <a href="#">Measure</a>				
3) Size: <a href="#">check</a>				
4) Type of tyre: <a href="#">check</a>				
5) Ply rating: <a href="#">check</a>				
6) Recommended inflation pressure, kPa				
i) For fieldwork: <a href="#">applicant's declaration to be endorsed.</a>				
ii) For transport: <a href="#">applicant's declaration to be endorsed.</a>				
7) Track width, mm: <a href="#">measure</a>				
8) Method of changing track width, range and number of steps: <a href="#">check</a>				
9) Method of changing track width, if any, and range: <a href="#">check</a>				
b) Steel wheel				
1) Track width, mm: <a href="#">measure</a>				
2) Type: <a href="#">check</a>				
3) Size				
i) Diameter, mm: <a href="#">measure</a>				
ii) Width, mm: <a href="#">measure</a>				
4) Total mass (2 wheels), kg: <a href="#">measure</a>				
<b>B-17 OPERATOR'S SEAT</b>				
a) Type: <a href="#">check</a>				
b) Type of suspension: <a href="#">check</a>				
c) Range of adjustment (if any), mm: <a href="#">measure</a>				
<b>B-18 MASS OF BALLAST</b>				
<i>Ballast Mass as Used, kg</i>				
	<i>Water</i>	<i>Cast Iron Weight on- Wheel</i>		
<i>Optional ballast</i>	<a href="#">measure</a>	<a href="#">measure</a>		
<b>B-19 MASS OF POWER TILLER (WITHOUT DRIVER BUT WITH LUBRICANT, FUEL AND COOLANT FULL)</b>				
<b>Total</b>	<b>Ballast</b>		<b>Unballast</b>	
<a href="#">Measure</a>	<a href="#">Measure</a>		<a href="#">Measure</a>	
<b>B-20 OVERALL DIMENTIONS (mm)</b>				
<i>Conditions</i>	<i>Length*</i>	<i>Width*</i>	<i>Height*</i>	<i>Ground Clearance</i>
<i>With ballast</i>	<a href="#">Measure</a>	<a href="#">Measure</a>	<a href="#">Measure</a>	<a href="#">Measure</a>
<i>Without ballast</i>	<a href="#">Measure</a>	<a href="#">Measure</a>	<a href="#">Measure</a>	<a href="#">Measure</a>
<i>* Measure the outermost points</i>				

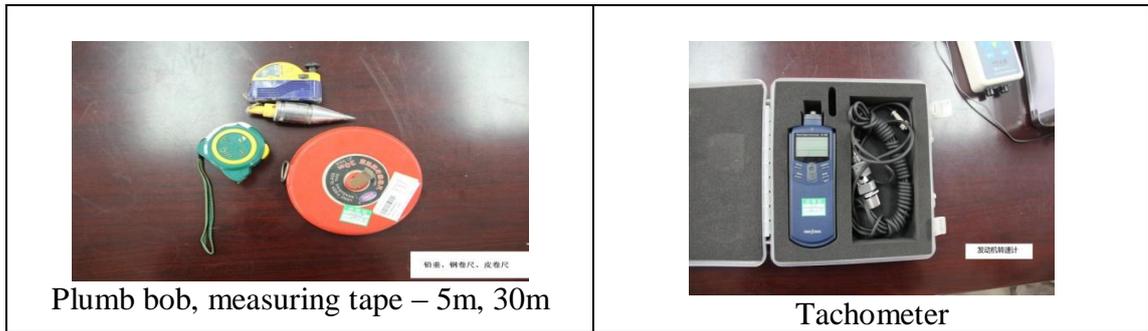
## PART THREE

### NOMINAL SPEED TEST MEASUREMENT

(See paragraph 3 of B-11 of Annex B)

#### 1.0 MEASUREMENT OF TEST DATA

- 1) Check & adjust the tyre pressure of power tiller recommended by the manufacturer for road work.
- 2) Define a certain distance S on track, e.g. 100 m for high speed and 50 m for low speed.
- 3) Measure the time T taken in seconds when the power till is driven through the certain distance at rated engine speed at different gears.
- 4) Photographs



- 5) Calculation the nominal speed at rated engine speed through the following formula

$$\text{Velocity} = (S/1000) / T/3600 = 3.6XS/T \text{ km/h}$$

#### 1.1 Observations

S. No.	Gear used	Distance in metre	Time in seconds	Nominal speed at rated engine speed, (km/h)
1.				
2.				
3.				
Etc.				

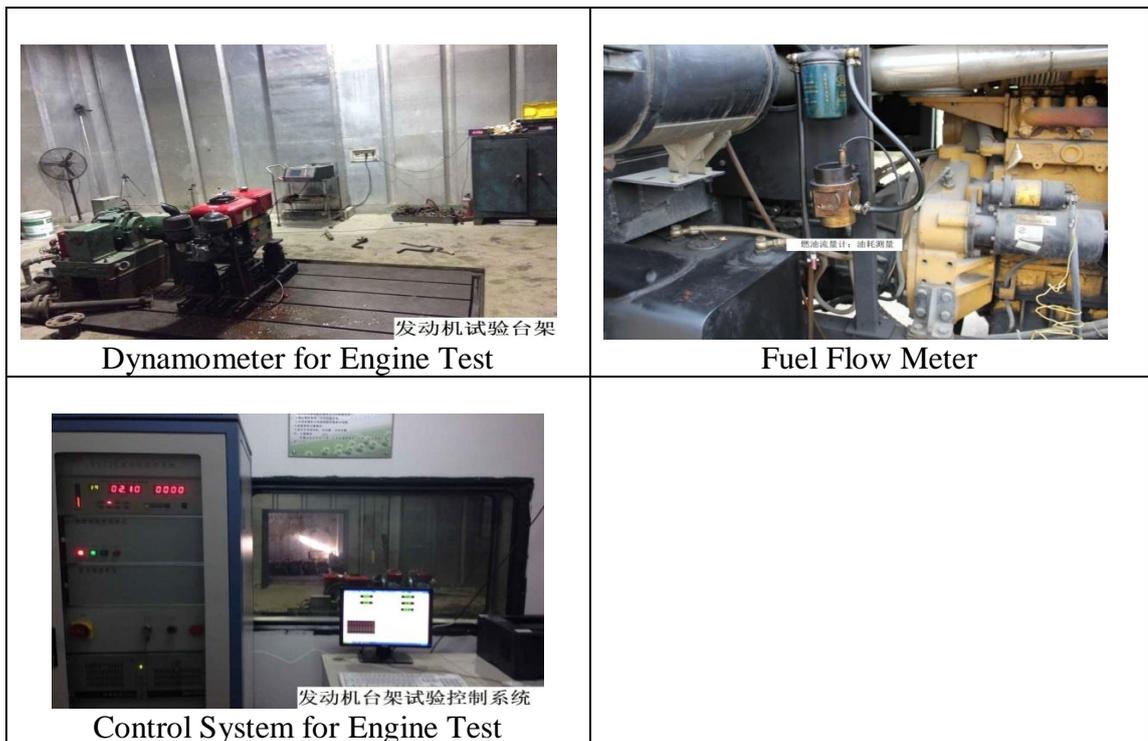
Park the power tiller after completion of test.

## PART FOUR

### ENGINE PERFORMANCE TEST

#### 1.0 GENERAL CHECKING BEFORE CONDUCT OF TEST

- 1) Remove the engine from the power tiller. Couple the engine with the dynamometer.
- 2) Check the angle of the connection of the shaft connecting the crankshaft to the dynamometer. The angle shall not exceed  $2^{\circ}$ .
- 3) Install the sensor for measurement of temperature of fuel, engine oil and coolant.
- 4) Measure the density of fuel.
- 5) Note down the Type of dynamometer used, Fuel used – Type & Density at  $15^{\circ}\text{C}$ , Engine oil used – Type & Grade, Transmission oil used, No load maximum engine speed, rpm.
- 6) Measure the ambient temperature (the surrounding temperature shall be  $27 \pm 7^{\circ}\text{C}$ ), atmospheric pressure (shall not be less than 96.6 kPa) etc.
- 7) The various tests shall normally be carried out continuously.
- 8) Photographs



#### 2.0 MEASUREMENT OF TEST DATA

##### 2.1 Maximum Power

- 1) Start the power tiller and governor control set for maximum power.
- 2) Warm up the engine to reach stabilized running conditions.
- 3) Start the test and search the maximum power of engine.
- 4) Operate the engine at the speed where maximum power occurs for a period of 2 hours.

- 5) Measure the power, torque and fuel consumption and other relevant parameters. Take at least six readings during the period of 2 hours (i.e. each measurement after every 20 minutes of interval).
- 6) Calculate the average of power observed in the six readings. If the power varies by more than  $\pm 2$  percent from the average, repeat the test. If the variation continues, report the deviation.

**Calculations:**

$$(a) \text{ Power (kW)} = \text{Engine speed (rpm)} \times \text{Crankshaft torque (Nm)} / 3000$$

Note: The value 3000 refers to dynamometer constant and hence may be different depending upon the dynamometer used in the test center. Test center is required to provide the value to be incorporated.

## 2.2 Power at Rated Engine Speed

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

- 1) Operate the engine at the rated speed for a period of 1 hour.
- 2) Measure the power, torque and fuel consumption and other relevant parameters. Take at least six readings during the period of 1 hour (i.e. each measurement after every 10 minutes of interval).
- 3) Calculate the average of power observed in the six readings. If the power varies by more than  $\pm 2$  percent from the average, repeat the test. If the variation continues, report the deviation.

## 2.3 Varying Speed at Full Load

- 1) Measure the power, torque and fuel consumption as a function of speed at full power at approximately 10 percent speed increments.
- 2) Measure the power, torque and fuel consumption and other relevant parameters for each increment of speed.
- 3) The minimum speeds at which measurements are made shall be at the speed of maximum torque and, if possible, 15 percent below that speed.

## 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.

- 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); and
- f) Unloaded [with the dynamometer disconnected if the residual torque is greater than 5 percent of the torque defined in (b)].

## 2.5 Five Hours Engine Rating Test

- 1) The engine shall be run continuously for 5 hours. For the first 4 hours, the engine shall be run at 80 percent of load (torque) corresponding to maximum power (7.6 SNI 0738:2014, TIS 787-2008 and 5.2.3 PNS/PAES 117:2000). 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).
- 2) Measure the power, torque and fuel consumption and other relevant parameters during the test.

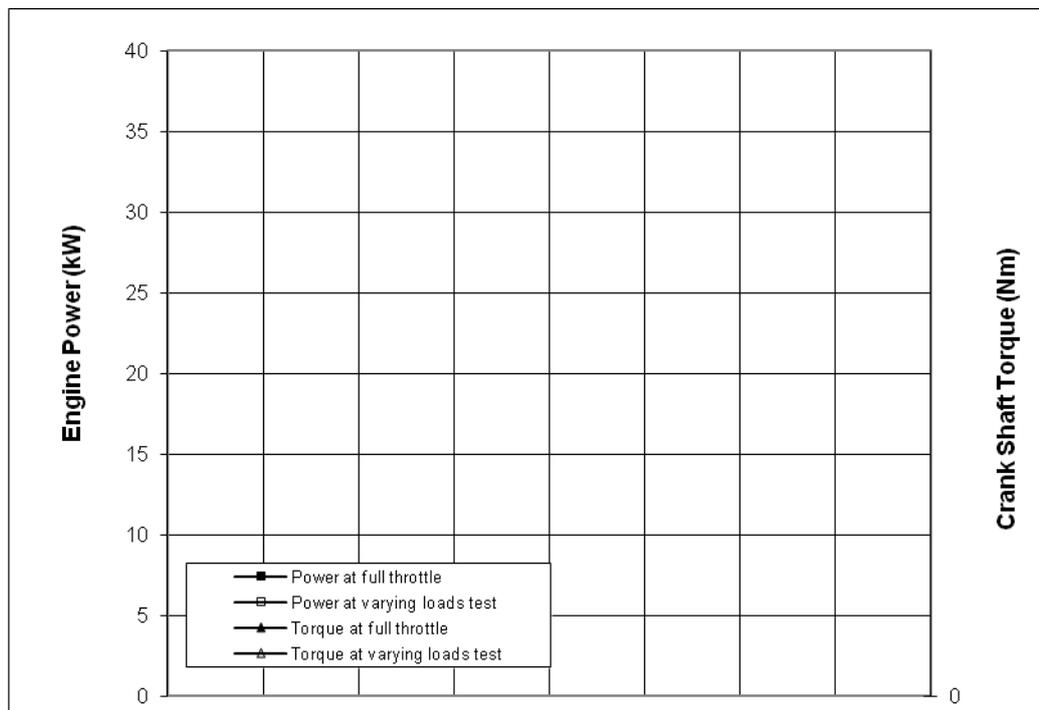
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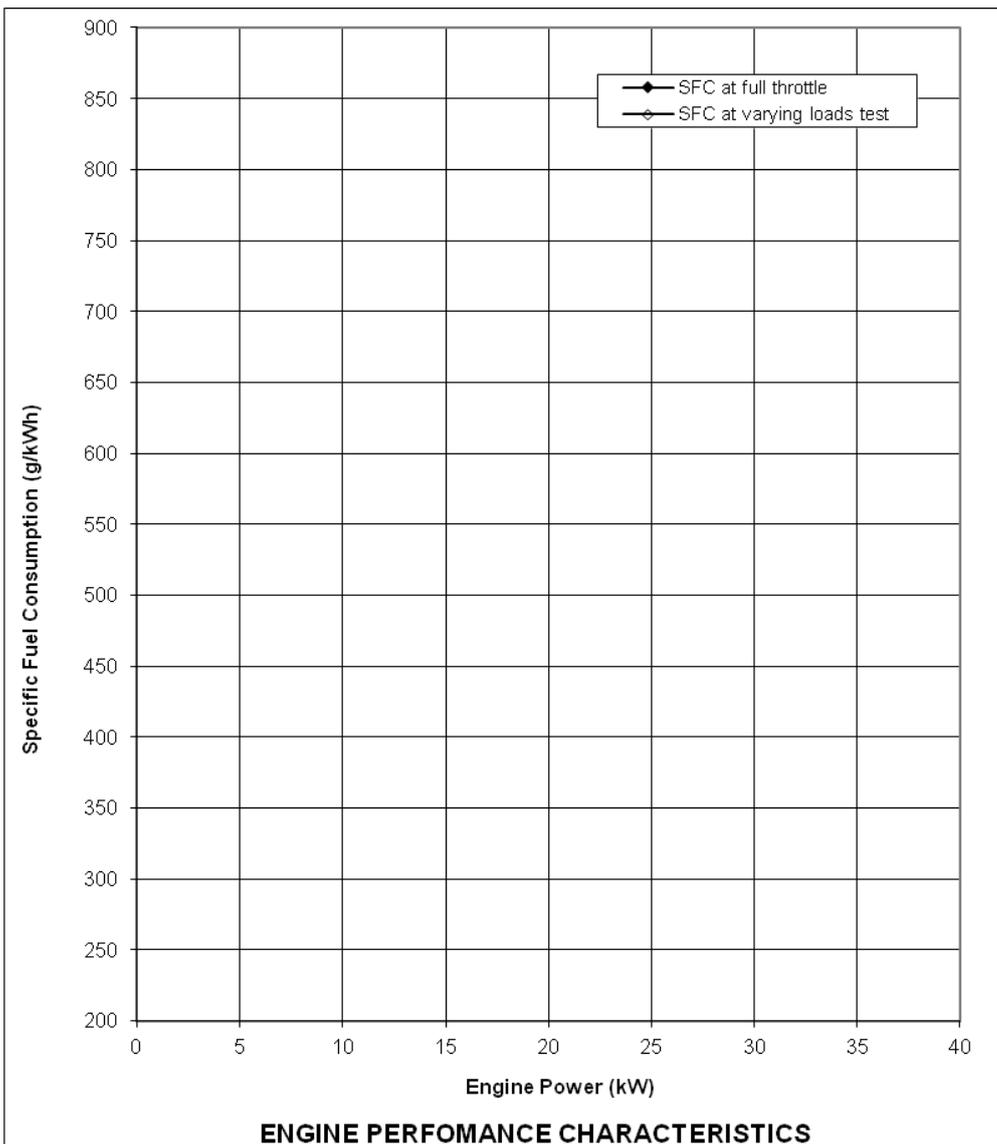
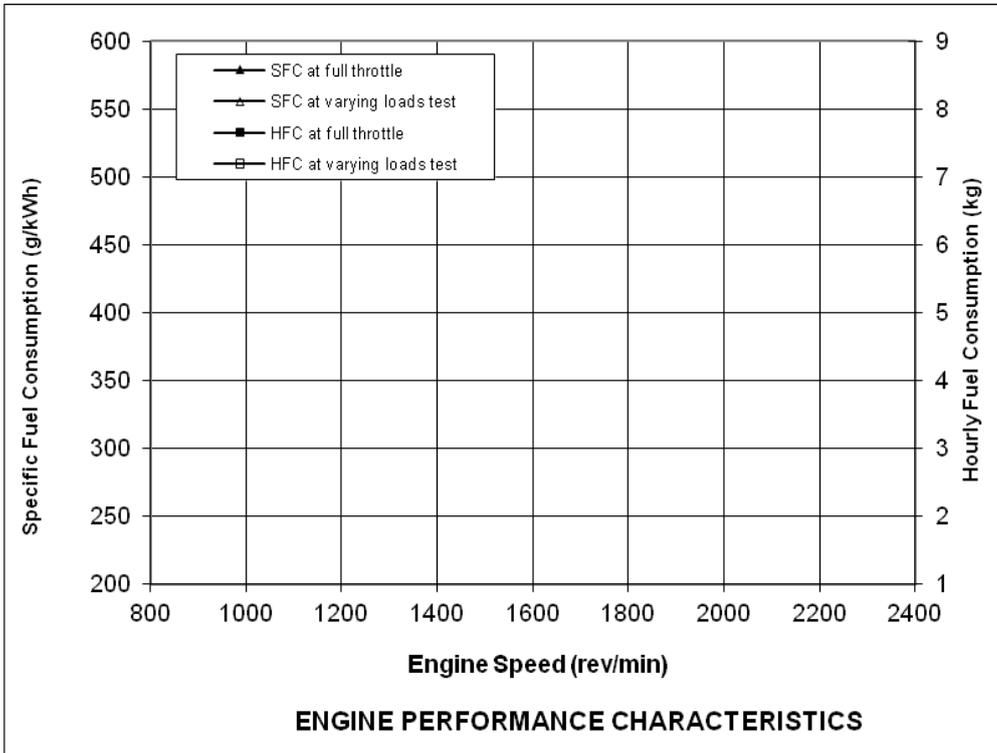
- (1) The engine may be unloaded and may be allowed to run for few minutes to lower down the engine oil and coolant temperature.
- (2) The engine may be stopped.

<b>D-6 ENGINE PERFORMANCE TEST DATA SHEET</b>													
Test Conditions	Test	Power (kW)	Crank Shaft Torque (N-m)	Engine Speed (rpm)	Fuel Consumption		Specific Energy (kWh/1)	Temperature, °C			Atmospheric Conditions		
					Hourly (kg/h)	Specific (g/kWh)		Fuel	Engine oil	Coolant	Temp (°C)	Relative Humidity (%)	Pressure (kPa)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Normal Ambient test	i) Maximum power test												
	ii) Power At Rated Engine speed												
-do-	Varying Engine Speed at Full Load i) ii) iii) iv) v) vi)												
-do-	Rated Engine Speed at Varying Load i) ii) iii) iv) v) vi)												

## 2.6 Presentation of Results

- 1) The data shall be reported in tabular form for each test condition (Annex D-6).
- 2) If also presented in graphical form (which is optional), the following, covering the full range of engine speeds tested, shall be included:
  - Power as a function of speed;
  - Torque as a function of speed;
  - Fuel consumption (mass) and specific fuel consumption (mass) as a function of speed;
  - Specific fuel consumption (mass) as a function of power;
  - Report the no-load maximum engine speed.





## PART FIVE

### DRAWBAR PERFORMANCE TEST

#### 1.0 GENERAL CHECKING BEFORE CONDUCT OF TEST

- 1) Check and measure the height of tyre tread bars at the centre line of the standard tyres. Should not be less than 65% of their height when new.
- 2) Check & adjust the tyre pressure of power tiller recommended by the manufacturer for field work.
- 3) Check the condition of concrete track - should be clean, horizontal and dry, containing a minimum number of joints.
- 4) Couple the unballasted power tiller with loading van.
- 5) Check the zero of load cell.
- 6) Install the sensor for measurement of 'Actual Travel speed' of the power tiller on load during the test.
- 7) Measure the density of fuel.
- 8) Calibration the fifth wheel.
- 9) Measure the ambient temperature, humidity, wind speed, air pressure etc.
- 10) Photographs





## 2.0 MEASUREMENT OF TEST DATA FOR MAXIMUM POWER AND PULL

- 1) Start the power tiller and governor control set for maximum power.
- 2) Check that the line of pull should be horizontal.
- 3) Take 2 - 3 rounds of power tiller on test track to achieve the stability of operational conditions.
- 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) After the operational conditions are stabilized, the measurements of engine speed, drawbar pull, fuel consumption, forward speed and wheel slip shall be recorded.

**Calculations:**

(a) Forward speed (km/h) = Distance (m) x 3.6 / Time (sec) (can be measured by fifth wheel directly during drawbar test, not need to calculation)

(b) Drawbar Power = Drawbar Pull (kN) x Forward speed (km/h) / 3.6

(c) Forward speed at No load (km/h) = (the speed can be measured by fifth wheel directly)

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

(d) Wheel slip (%) =

- 6) Increase the drawbar pull and repeat the measurements as in (4) above. The maximum pull and maximum power shall be recorded at power tiller wheel slippage only up to 15 percent.
- 7) The set of measured data for each selected gear shall be recorded in the following format:

**D-8 TEST DATA DRAWBAR PERFORMANCE TEST**

Test	Gear Number Used	Travel Speed (km/h)	Drawbar Pull (kN)	Drawbar Power (kW)	Wheel Slip (%)	Engine Speed (rpm)	Fuel Consumption			Atmospheric Conditions		
							kg/h	g/kWh	kWh/l	Temp. (°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)	H1											

- 8) The test shall be conducted until the maximum power and pull are found in different forward speed gears.
- 9) Compilation of data in the Test Report may be as under - Select one of the measured data of maximum power and or pull from the set of readings obtained in (7) for each gear. Same may be repeated for other different gears and may be tabulated as under.

**D-8 TEST DATA DRAWBAR PERFORMANCE TEST**

Test	Gear Number Used	Travel Speed (km/h)	Drawbar Pull (kN)	Drawbar Power (kW)	Wheel Slip (%)	Engine Speed (rpm)	Fuel Consumption			Atmospheric Conditions		
							kg/h	g/k	kWh/l	Temp. (°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)	H1											
	L3											
	L2											
	L1											

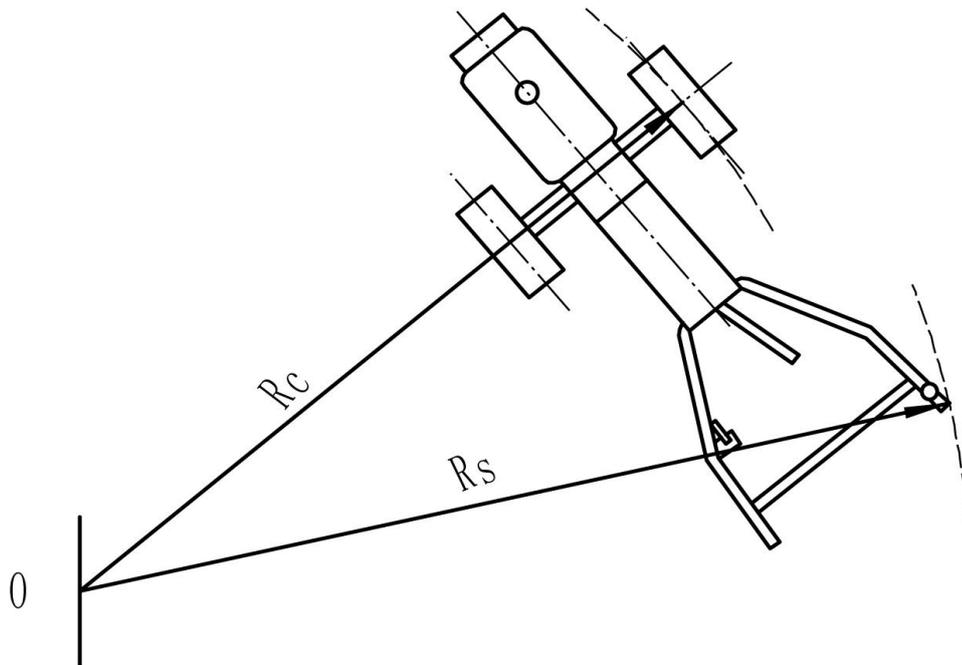
- 10) Park the power tiller after completion of test.

## PART SIX

### TURNING ABILITY TEST

#### 1.0 GENERAL CHECKING BEFORE CONDUCT OF TEST

- 1) Check the test area - the test area shall be a horizontal compacted or paved surface having good tire adhesion and capable of displaying legible marking.
- 2) Check the power tiller - all liquid reservoirs filled to the specified level but without ballast, mounted implements and any other specified components.
- 3) Check the tyres - At the beginning of the test, the height of the tyre tread bars shall not be less than 65% of their height when new. The inflation pressure shall be maintained as recommended for the road work by the manufacturer.



$R_s$ =turning space radius

$R_c$ =turning circle radius

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

#### 2.0 MEASUREMENT OF TEST DATA

- 1) The test shall be conducted with the power tiller without tailed wheel at the minimum attainable speed.
- 2) The measurement of the turning circle and turning space are referred in figure 1.

- 3) 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.
- 4) During the test the following shall be recorded:
  - a) Diameter of the minimum turning circle, and
  - b) Diameter of the minimum turning space required.
- 5) The data shall be recorded in D-4.

<b>D-4 TURNING ABILITY</b>				
a) Details of wheels 1) Wheel track, mm: <i>measure</i> 2) Size of tyres: <i>check</i> 3) Pressure of tyres, kPa: <i>Check &amp; measure</i>				
b) Test data				
<i>Description</i>	<i>Minimum Turning Diameter</i>		<i>Minimum turning Space Diameter</i>	
	<i>Right Hand Side (m)</i>	<i>Left Hand Side (m)</i>	<i>Right Hand Side (m)</i>	<i>Left Hand Side (m)</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>
<i>With Steering Clutch</i>	<i>measure</i>	<i>measure</i>	<i>measure</i>	<i>measure</i>

## PART SEVEN

### PARKING BRAKE TEST

#### 1.0 GENERAL CHECKING BEFORE CONDUCT OF TEST

- 1) The performance of the parking brake shall be based on the ability to hold the power tiller stationary, facing up and down slopes.
- 2) Check the power tiller - shall be attached with any matching implement e.g. rotary, plough etc. and without ballast.
- 3) Check the test track – test shall be conducted on a clean, flat and dry concrete test track.
- 4) Photograph



20% slope

#### 2.0 PROCEDURE

- 1) Install load cell and indicator to measure the parking device control force.
- 2) Start the power tiller and take it to the test area.
- 3) The power tiller shall be placed out of gear on a slope of not less than 18% 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.
- 4) 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.
- 5) The data shall be recorded in Annex D-5.

<b>D-5 PARKING BRAKE TEST</b>		
Power tiller mass, kg:		
Degree of slope ( $^{\circ}$ ):		
<i>Observations</i>	<i>Parking Braking Device Facing up Slope</i>	<i>Parking Braking Device facing Down Slope</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
<i>Parking device control force (N)</i>	<i>Measure</i>	<i>Measure</i>
<i>Whether rolling of braking wheels noticed</i>	<i>Yes/No Check</i>	<i>Yes/No Check</i>
<i>Efficacy of brakes</i>	<i>Yes/No Check</i>	<i>Yes/No Check</i>

Note:

- (1) The engine may be stopped and park the power tiller in the parking area.

## PART EIGHT

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

#### 1.0 GENERAL CHECKING BEFORE CONDUCT OF TEST

##### 1.1 Sound Level Meter

- 1) Sound level meter which meets at least the requirements of IEC 651 for a type 1 instrument shall be used.
- 2) The noise shall be measured with instrument of A weighted expressed in decibels set on slow level.
- 3) Photograph



Sound Level Meter

##### 1.2 Test Area and Other Conditions

- 1) Check 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.
- 2) Check the air temperature & wind velocity: the air temperature shall be in the range from  $-5\text{ }^{\circ}\text{C}$  to  $35\text{ }^{\circ}\text{C}$  and the wind velocity shall not exceed 5 m/s at the operator's position (9.2.4 GB/T 6229-2007).
- 3) Check the microphone position: for seated operators, the microphone shall be located  $250\text{ mm} \pm 20\text{ mm}$  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  $700\text{ mm} \pm 20\text{ mm}$  above the seat index point and  $100\text{ mm} \pm 20\text{ mm}$  forward of that point. Excessive vibration of the microphone shall be avoided. The seat index point shall be determined in accordance with ISO 5353.

## **2.0 PROCEDURE**

- 1) The noise measurement test shall be conducted at the operator's ear level during the drawbar pull test.
- 2) 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.
- 3) 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.
- 4) 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.
- 5) The data shall be recorded in Annex E.

**ANNEX E**

*(Clause 6.2)*

**DATA SHEET FOR NOISE MEASUREMENT**

<b>E-1 AT OPERATOR'S EAR LEVEL</b>						
<b>E-1.1 Brief Description of the Silencing System</b>					Check & report	
<b>E-1.2 Background Noise Level, dB (A)</b>					Measure	
<b>E-1.3 Sound Level Meter</b> Sound Level Meter 1) Type: 2) Make: 3) Model:					Check & report	
<b>E-1.4 Date of Test</b>						
<b>E-1.5 Atmospheric Conditions</b> a) Temperature, °C b) Pressure, kPa c) Relative humidity, %					Measurement	
<b>E-1.6 Test Data</b>						
<i>No</i>	<i>Gear Used</i>	<i>Travelling Speed (km/h)</i>	<i>Engine Speed (rpm)</i>	<i>Slip (%)</i>	<i>Drawbar Pull (kN)</i>	<i>Sound Level dB (A)</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>	<i>(6)</i>	<i>(7)</i>
1	Report	Measure	Measure	Measure	Measure	Measure
2	Report	Measure	Measure	Measure	Measure	Measure
3	Report	Measure	Measure	Measure	Measure	Measure
4	Report	Measure	Measure	Measure	Measure	Measure
5	Report	Measure	Measure	Measure	Measure	Measure
6	Report	Measure	Measure	Measure	Measure	Measure

Note:

- (1) The engine may be may be stopped and park the power tiller in the parking area.



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