Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of AFMA Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA).

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

In the preparation of this standard, the following documents/publications were considered:

Organisation for Economic Co-operation and Development (OECD) Standard Code for the official Testing of Agricultural and Forestry Tractor Performance : Code 1. March 2000.

International Organization for Standardization (ISO)/R 789 : 1968 (E) – Test Code for Agricultural Tractors

Regional Network for Agricultural Machinery (RNAM) Test Codes And Procedures for Farm Machinery. Technical Series No. 12 :1983.

All annexes in this standard are normative.

Agricultural Machinery – Four-Wheel Tractor – Methods of Test

1 Scope

This standard specifies the methods of test and inspection for four-wheel tractor. Specifically, it shall be used to:

1.1 verify the requirements specified in PAES 118 and the specifications submitted by the manufacturer;

1.2 evaluate the operator's manual as to clarity, usefulness and adaptability

1.3 determine the laboratory performance of the machine

1.3.1 power-take-off (PTO) performance test

1.3.1.1 maximum power test

1.3.1.2 test at full load and varying speed

1.3.1.3 test at varying load

1.3.2 hydraulic lifting force and power test

1.3.3 drawbar power test – ballasted and unballasted tractor

1.3.4 turning area and turning circle

1.3.5 position of center of gravity

1.3.6 braking test

1.4 determine the field performance of the machine

1.5 prepare a report on the results of the tests

2 References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this National Standard:

PAES 103:2000, Agricultural Machinery – Method of Sampling

PAES 118:2001, Agricultural Machinery – Four-Wheel Tractor – Specifications

ISO 730-1:1994, Rear-mounted three-point linkage – Categories 1, 2, 3 and 4

ISO 789-6:1982 *Agricultural Tractors - Test Procedures - Part 6: Centre of Gravity* and its Amendment Amd 1:1996

International Electro-technical Commission Standard IEC 60651:1979 *Sound level meters* + Am1: 1993

3 Definitions

For the purpose of this standard, the definitions given in PAES 118 and the following shall apply:

3.1
ballast
any material added to the tractor for the purpose of enhancing traction or stability

3.2
engine power
power measured at the flywheel or the crankshaft

3.3
ground clearance
distance between the supporting surface and the lowest point of the tractor

3.4
maximum drawbar pull
mean maximum sustained pull of the tractor at the drawbar over a given distance, the pull being exerted horizontally and in the vertical plane containing the longitudinal axis of the tractor

3.5
tractor weight
total weight of the tractor excluding tools with the fuel tank filled to 80 percent capacity and with normal amounts of cooling water and lubricating oil when the tractor is at work

3.6
overall height
distance between the supporting surface and the horizontal plane touching the uppermost part of the tractor (see Figure 1)

3.7
overall length
distance between the two vertical planes at right angles to the median plane of the tractor and touching its front and rear extremities (see Figure 1)

3.8
overall width
distance between two vertical planes parallel to the median plane of the tractor, each plane touching the outermost point of the tractor on its respective side (see Figure 1)

NOTE All parts of the tractor, in particular all fixed components projecting laterally (i.e. wheel hubs), are contained between these two planes.

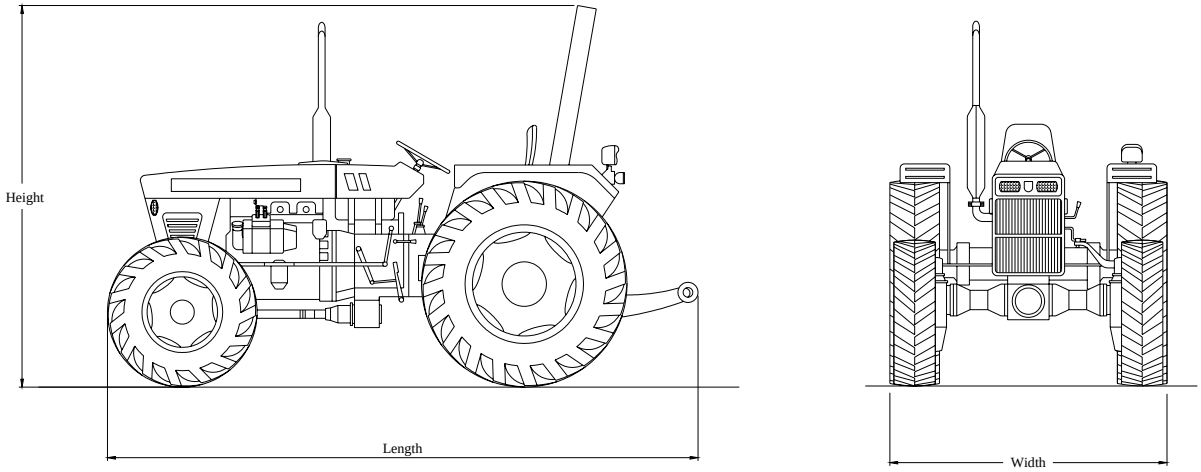

Figure 1 – Dimension of Four-Wheel Tractor

3.9
radius of turning area
radius of clearance circle
radius of the smallest circle described by the outermost point of the tractor (see Figure 2)

3.10
radius of turning circle
radius of the smallest circle tangentially described by the median plane of the outermost wheel of the tractor (see Figure 2)

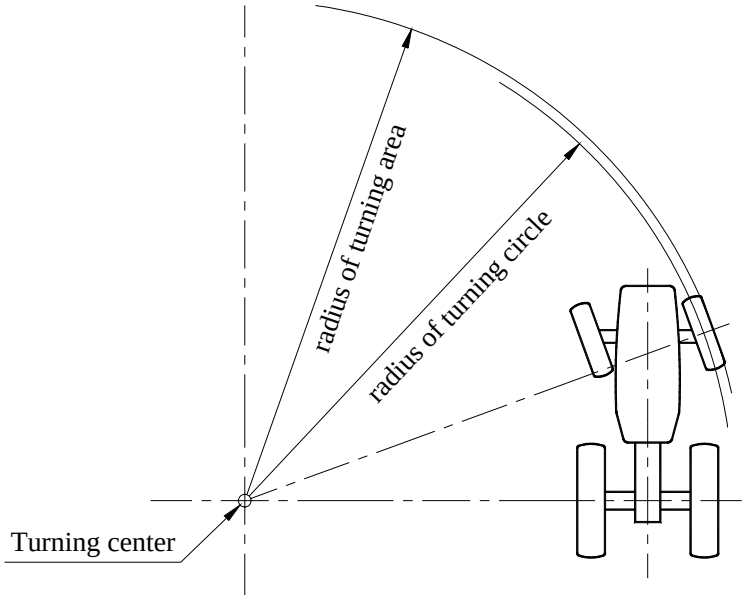

Figure 2 – Radius of turning area and radius of turning circle

3.11
rated engine speed
speed in revolutions per minute specified by the manufacturer

3.12
wheel slip
slip of the driving wheels is determined by the following formula

$$Wheel\ slip = \frac{N_1 - N_0}{N_1}\ x\ 100$$

where:

N_1 is the sum of the revolutions of all driving wheels for a given distance with slip, rpm

N_0 is the sum of the revolutions of all driving wheels for the same distance without slip, rpm

3.13
specific fuel consumption
quantity of fuel consumed by an engine on the basis of per horsepower hour

4 General Conditions for Test and Inspection

4.1 Four-wheel tractor on Test

The tractor submitted for test shall be sampled in accordance with PAES 103.

4.2 Role of the manufacturer/dealer

The manufacturer/dealer shall submit to the official testing agency the specifications and other relevant information on the four-wheel tractor. An official representative shall be appointed to conduct minor repair, adjust and witness the test. It shall be the duty of the representative to make all decisions on matters of adjustment and preparation of the machine for testing. The manufacturer/dealer shall abide by the terms and conditions set forth by the official testing agency.

4.3 Running-in and preliminary adjustments

The tractor shall be new and run-in by the manufacturer before the test in collaboration with the testing station, under the responsibility of the manufacturer/dealer and in accordance with its usual instructions. If this procedure is impractical due to the tractor being an imported model, the testing station may itself run in the tractor provided that the authority of the manufacturer or his representative is obtained.

The adjustment of the carburetor or the injection pump and the setting of the governor shall conform to the specifications provided by the manufacturer. The manufacturer may make adjustments in conformity with the specifications during the period prior to testing. These adjustments shall not be changed during the test. The test report shall state the place and duration of running in.

4.4 Ballasting

Ballast weights may be fitted. For tractors having pneumatic tires, liquid ballast in the tires may also be used; the overall static weight on each tire (including liquid ballast in the tires and a 75 kg weight representing the driver), and the inflation pressure shall be within the limits specified by the tire manufacturer, except as specified for the five-hour test.

4.5 Fuels and lubricants

Fuels and lubricants shall be selected from the range of products commercially available in the country where the equipment is tested but shall conform to Philippine National Standards.

4.6 Auxiliary equipment

For all tests, accessories such as the hydraulic lift pump or air compressor may be disconnected only in accordance with the Operator's Manual and without using tools if it is practical for the operator to do so as normal practice in work. Except as otherwise specified for a particular test, accessories should remain connected and operated at minimum load.

4.7 Operating conditions

No corrections shall be made to the test results for atmospheric conditions or other factors. Atmospheric pressure shall not be less than 96.6 kPa. If this is not possible because of conditions of altitude, a modified injection pump setting may have to be used, details of which will be included in the report. The pressure will be noted in the report. Stable operating conditions must be attained at each load setting before beginning test measurements.

4.8 Measuring instruments

The measuring instruments to be used shall be checked and calibrated by the testing station prior to the measurements and shall be such that the following items to be measured with the minimum scale of accuracy as shown in Table 1:

Table 1 – Minimum Scale of Accuracy for Different Parameters

Item	Minimum Scale of Accuracy
Distance	1 mm
Weight	1 kg
Time	0.5 s
Rotational speeds	1 % of measured value
Temperature	1 °C
Volume	10 ml
Drawbar pull	1 % of measured value
Pressure	1 % of measured value

4.9 Repairs during tests

All repairs made during the tests shall be noted together with comments on any practical defect.

4.10 Suspension of test

If during the test run the machine malfunctions affecting its performance, the test may be suspended with the concurrence of the official testing station and the manufacturer's representative. In case of engine failure, same can be changed with an identical unit (if the engine is not integrated with the tractor).

5 Tests and Inspection

5.1 Verification of Manufacturer's Technical Data and Information

5.1.1 This investigation is carried out to verify that the mechanism, main dimensions, weight and attachments of the tractor conform to the list of technical data and information submitted by the manufacturer.

5.1.2 While checking the dimensions:

5.1.2.1 the tractor must be standing on a hard horizontal surface. Dimensions of length and width are then measured on horizontal lines and those of height on vertical lines; and

5.1.2.2 unless otherwise stated, the tractor must be stationary with its wheels or tracks and components in the positions they would be in if the tractor was to travel in a straight line.

5.1.3 The items to be inspected and verified are given in Annex A.

5.2 Laboratory Performance Tests

5.2.1 PTO performance test

5.2.1.1 Test conditions

The torque and power values in the test report shall be obtained from the dynamometer bench without correction for losses in power transmission between the power take-off and the dynamometer bench. In all tests, the shaft connecting the power take-off to the dynamometer shall not have any appreciable angularity. The use of an exhaust gas discharge device must not change the engine performance.

5.2.1.2 Maximum power test

With the governor control set for maximum power, the tractor shall operate for a period of two hours after a sufficiently long warming-up period to stabilize power. The maximum power noted in the test report shall be the average of the readings made during the two-hour period. If the power variation deviates by more than 2% from the average, the test shall be repeated. If the variation continues, the deviation shall be stated in the report. A minimum of six readings shall be made during the two-hour test period with equal intervals.

5.2.1.3 Test at full load and varying speed

The hourly fuel consumption, torque and power are measured as a function of speed. To plot the curves, the test shall go down to an engine speed at least 15% below the speed at which maximum torque occurs or to an engine speed at least 50% of rated engine speed, whichever speed is lower. This is subject to any limitation such as safe operation of the tractor and test equipment or as stated by the manufacturer in agreement with the testing station.

5.2.1.4 Test at varying load

The governor is set for maximum power at rated engine speed and at standard power-take-off speed (540 and/or 1000 rpm). Torque, engine speed and hourly fuel consumption shall be recorded at the following loads:

5.2.1.4.1 the torque corresponding to maximum power available at rated engine speed and at standard power-take-off speed;

5.2.1.4.2 85 percent of the torque obtained in 5.2.1.4.1;

5.2.1.4.3 75 percent of the torque obtained in 5.2.1.4.2;

5.2.1.4.4 50 percent of the torque obtained in 5.2.1.4.2;

5.2.1.4.5 25 percent of the torque obtained in 5.2.1.4.2;

5.2.1.4.6 Without load (with the brake disconnected if the residual torque is greater than 5% of the measured value in 5.2.1.4.2).

5.2.1.4.7 The items to be measured and recorded are given in Annex B.

5.2.2 Hydraulic lifting force and power

Tractors without a lifting system and/or without a hydraulic service coupling remain eligible under this test Standard.

However, the design of these tractors shall be specified in the test report.

5.2.2.1 Test conditions

The hydraulic fluid shall be as recommended by the manufacturer. The governor control lever shall be set for maximum power. At the start of each test, the temperature of the hydraulic fluid in the tank shall be measured. A pressure gauge shall be fitted immediately next to the external tapping of the tractor.

The tractor shall be so secured that the reactive force of the power lift deflects neither tires nor suspension. The linkage shall be adjusted in the same way both with or without the coupled frame to achieve typical arrangements as follows:

a. the linkage shall be adjusted in accordance with the tables in ISO 730-1. For those tractors which do not achieve the standard power range, the lift force will be measured at the maximum achievable power range;

b. the upper link shall be adjusted to the length necessary to bring the mast of the frame vertical when the lower links are horizontal;

c. where more than one upper or lower link point is available on the tractor, the points used shall be those specified by the manufacturer and shall be included in the test report;

d. where there is more than one attachment point to connect the lift rods to the lower links, the connection points used shall be those specified by the manufacturer and shall be included in the test report;

e. these initial adjustments, as far as possible, shall cause the mast to turn through a minimum of 10° from the vertical to the angle at which the frame is in the uppermost position. If this is not possible, the fact shall be stated in the test report; and

f. the oil pressure shall be checked during the test.

5.2.2.2 Lifting force

5.2.2.2.1 Lift at lower hitch points

An external vertical downward force shall be applied to a horizontal bar connecting the lower hitch points. This force shall remain as vertical as possible throughout the lift range. If necessary, the values of measurement will have to be corrected.

The lifting force available and the corresponding pressure of the hydraulic fluid shall be determined at a minimum of six points approximately equally spaced throughout the range of movement of the lift, including one at each extremity. At each point, the force shall be the maximum which can be exerted against a static load. Additionally, the range of movement shall be reported. The pressure recorded during the test must exceed the minimum relief valve pressure setting.

The values of force measured shall be corrected to correspond to a hydraulic pressure equivalent to 90% of the actual relief valve pressure setting of the hydraulic lift system. The corrected value of the lowest lifting force constitutes the maximum vertical force which can be exerted by the power lift throughout its full range of movement.

5.2.2.2.2 Lift on a coupled frame

A frame having the following characteristics shall be attached to the three-point linkage:

a. the mast height and the distance from the hitch points to the centerline of the tractor shall be appropriate to the linkage category. Where more than one category is specified, that chosen for the test shall be at the manufacturer's option.

b. the center of gravity shall be at a point 610 mm to the rear of the lower hitch points, on a line at right angles to the mast and passing through the middle of the line joining the lower hitch points.

Testing conditions and procedure shall be as in 5.2.2.2.1 The weight of the frame shall be added to the force applied.

5.2.2.3 Hydraulic power

The different values of the pump delivery rate shall be measured using a designated auxiliary service coupling with measuring equipment causing negligible pressure drop in the external line. The following results shall be reported:

a. the pressure sustained by the open relief valve, with the pump stalled in the case of a closed-center system with pressure-compensated variable delivery pump;
b. the pump delivery rate at minimum pressure;
c. the hydraulic power at the auxiliary service coupling, at the flow rate corresponding to a hydraulic pressure equivalent to 90% of the actual relief valve pressure setting in the circuit;

d. the maximum hydraulic power available at the auxiliary service coupling and the corresponding oil flow and hydraulic pressure; and
e. the opening and closing pressures of the unloading valve in the case of a closed-center system having an accumulator.

5.2.2.4 The items to be measured and recorded are given in Annex C.

5.2.3 Drawbar power – ballasted and unballasted tractor

5.2.3.1 Test conditions

5.2.3.1.1 *Tire sizes*

This test may be carried out on one or more sets of tires of different sizes, and the several results included in the test report.

5.2.3.1.2 *Test track*

The tests at the drawbar shall be conducted according to the following regulations in order to provide reasonably comparable results in all countries.

The tests shall be carried out on a clean, horizontal, and dry concrete or tarmacadam surface containing a minimum number of joints. Tractors that are not suitable for operation on concrete or tarmacadam surfaces, such as steel-wheeled or steel-tracked tractors shall be tested on flat, dry and horizontal, mown or grazed grassland, or on a horizontal track having equivalent adhesion characteristics. A moving track (treadmill) may also be used subject to the condition that results produced are comparable to those obtained on the surfaces mentioned above. The type of test track shall be clearly stated in the report.

5.2.3.1.3 *General requirements*

During all the tests at the drawbar, the governor control shall be set for maximum power. Tests shall not be made in gears in which the forward speed will then exceed the safety limits of testing equipment. The line of draught shall be horizontal. The height of the drawbar shall remain fixed in relation to the tractor during each test. It shall be chosen by the manufacturer in such a way that the direction of the tractor can be controlled when it develops maximum drawbar pull. In the case of wheeled tractors, the following relationship shall be verified:

$$PH \leq 0.8\ WZ$$

where: **P** is the maximum drawbar pull, kN
H is the static height above ground of the line of draught, mm
W is the static weight exerted by the front wheels on the ground, kN
Z is the wheelbase, mm

When testing four-wheel drive tractors with a differential connection between driving axles, the drawbar height must be selected so as to keep adhesion consistent between front and rear wheels when the drawbar pull reaches its maximum.

At the beginning of the drawbar tests, the height of the tire or rubber track tread bars shall not be less than 65% of the height of the bars of the tires or tracks when new. The height of the tire tread bars shall be measured by use of a three-point gauge. The gauge shall be placed astride the tread bar and perpendicular to the direction of the tread bar as close to the centerline of the tire or track as possible. Two legs of the gauge shall be positioned at the base of the tread bar (at the point of tangency between the tire or track carcass and the radius joining the tread bar to the carcass). The third point of the gauge shall be in the center of the tread bar. The tread bar height shall be the difference in elevation between the two outside legs of the gauge and the center point. The tread bar height measured in this manner shall be taken and averaged for a minimum of four equally spaced locations round the periphery of the tire or track**.** It shall be compared to similar data on a new tire or track of the same make, size and type.

For each gear at the speed and pull giving maximum power in that gear, there shall be recorded the engine speed, power, drawbar pull, speed, slip of wheels or tracks, fuel consumption, temperature of fuel, coolant and lubricating oil and the atmospheric conditions.

During tests the atmospheric temperature shall not exceed 35°C.

In the case of wheeled tractors performance values only up to 15% mean wheel slip shall be reported. As the no-slip distance will vary according to the degree of wear of the tires it will be necessary to check this regularly, particularly before determining maximum drawbar power. With track-laying tractors the maximum drawbar pull, together with the corresponding track slip, and also the point corresponding to a track slip of 7% or more shall be stated as a footnote beneath the table giving drawbar power values.

If possible, tracklaying tractors can be tested on a dry concrete or tarmacadam surface. In such a case, test procedure and conditions shall be those applicable to wheel tractors.

If the tractor is equipped with a hydrokinetic torque converter fitted with a "lock-out" device that is controlled by the driver, the drawbar tests shall be carried out in succession with the multiplier in operation and with the multiplier locked out.

In the case of tractors with a steplessly variable transmission, it is of course not possible to record the maximum power in the chosen gear ratios. The drawbar power envelope curve shall be obtained by determining the maximum powers for a sufficient number of transmission ratios to enable an accurate envelope curve to be drawn. Power values shall then be reported, read off from this envelope at the following speeds:

Wheeled and comparable tractors:							
km/h	2.5	3.5	5.0	6.5	8.0	11.0	17.5
Track laying tractors:							
km/h	1.5	2.5	3.5	5.0	6.5	8.0	10.0

In addition, for tractors with a steplessly variable transmission, the following data read off the curve shall be reported:

- Maximum power, fuel consumption and corresponding speed; and
- Maximum power and corresponding drawbar pull with traveling speed control and engine governor control in the position giving maximum speed.

5.2.3.2 Drawbar power test, unballasted tractor

Tests will determine the power available at the drawbar of the unballasted tractor over a range of gears.

Tests shall be made at least in those gears giving a travel speed faster than in the gear in which the greatest maximum power is developed to that immediately below the gear allowing maximum pull to be developed.

5.2.3.3 Drawbar power test, ballasted tractor

A second test series shall be performed on the tractor, ballasted in accordance with the manufacturer's specifications. The tests shall cover all gears from that giving the lowest travel speed to that giving a travel speed faster than in the gear in which the greatest maximum power is developed.

5.2.3.4 Five-hour test

5.2.3.4.1 Tractors, ballasted as for 5.2.3.3, will be tested for 5 hours in the gear designated by the manufacturer, in agreement with the testing station. This speed shall be one normally used for basic agricultural work such as plowing but as far as possible a different gear group from that used in 5.2.3.4.2 below. The drawbar load applied shall be 75 % of the pull corresponding to maximum power at rated speed in the selected gear. Values of power, pull, forward speed, slip and fuel consumption shall be included in the report.

In the case of tractors fitted with a hydrokinetic torque converter that can be locked out by the driver, the 5-hour test shall be carried out with the torque converter in operation, within the limitations specified by the manufacturer in his published instructions. If the limiting conditions are reached, the test shall be completed with the torque multiplier out of operation; the respective duration of the two parts of the test shall be noted in the report and the fuel consumption separately stated.

5.2.3.4.2 Following test 5.2.3.4.1 above, with a cooling interval between, tractors will be tested for a further five hours at the drawbar pull giving at most 15% wheel slip measured during test 5.2.3.3 above. The gear used shall be the fastest gear in which the required pull can be obtained when the engine is operating under the control of the governor. It may be necessary to add supplementary ballast to reduce tire wear and to have proper control of the tractor, within the load limitations specified by the manufacturer for this test. Pull, forward speed, temperatures and atmospheric conditions will then be recorded. Tractors fitted with a hydrokinetic torque converter that can be locked-out by the driver shall be treated as in 5.2.3.4.1 above.

5.2.3.4.3 During the ten hours of these two tests the engine lubricating oil consumption shall be measured and expressed in units of mass per hour.

5.2.3.5 Ten-hour test for the special case of track laying tractors

For steel track-laying and steel-wheeled tractors one test of ten hours shall be made as otherwise specified in 5.2.3.4.1 and 5.2.3.4.3. This test shall be carried out in two five-hour periods, with a cooling interval in between.

5.2.3.6 The items to be measured and recorded are given in Annex D.

5.2.4 Turning area and turning circle

5.2.4.1 Test conditions

These measurements shall be made on a test track. The wheel tread setting shall be as specified by the manufacturer. The tractor shall be unballasted and moving slowly at approximately 2 km/h.

5.2.4.2 Test procedure

Tests shall be made with the tractor turning right and then turning left without using the steering brakes.

Four-wheel-drive tractor with disconnectable front-wheel-drive shall be measured with front-wheel drive disengaged.

Tractors which have front and rear steering wheels and which have devices for disconnecting the steering of one or both axles shall be tested in that configuration which provides the smallest radius. Other steering combinations can be tested at the option of the testing station.

For track-laying tractors which can turn on the spot and thus have no measurable turning circle, the radius of the turning area only shall be reported. This shall be the distance from the center of rotation to that point on the tractor that describes the largest circle.

The items to be measured and recorded are given in Annex E.

5.2.5 Position of center of gravity

The test conditions and procedures outlined in ISO 789-6 may be used to determine the position of the center of gravity of the test tractor.

This shall be determined with full tanks and the driver replaced by a weight of 75 kg on the driver's seat, the tractor being otherwise unballasted.

The items to be measured and recorded are given in Annex F.

5.2.6 Braking test

This test may be omitted for track laying tractors which are not suitable for operation on the road.

5.2.6.1 Test conditions

The performance of service braking devices shall be based on the mean deceleration calculated over the stopping distance. The stopping distance shall be the distance covered by the tractor from the moment when the driver begins to actuate the control of the device until the moment when the tractor stops. The performance of the parking braking devices shall be based on the ability to hold the tractor stationary, facing up and down slopes.

The braking performance shall be measured during road tests conducted under the following conditions:

a. the tractor mass shall be as prescribed for each type of test and be specified in the test report;

b. the braked axle wheels shall be fitted with the highest load capacity tires used in normal agricultural work;

c. the road shall have a surface affording good adhesion;

d. the test shall be performed when there is no wind liable to affect the results;

e. at the start of the tests the tires or rubber tracks shall be cold. The pressure in the tires or the track drive and suspension system shall be as prescribed for the load actually borne by them when the tractor is stationary; and

f. The performance shall be measured without locking the brakes.

During the tests the tractor shall be fitted with any parts intended by the manufacturer for the operation of towed vehicle braking devices.

5.2.6.2 Cold service braking device test

5.2.6.2.1 The brakes must be cold at the beginning of the test. A brake is deemed to be cold if any of the following conditions is met:

a. the temperature measured on the disc or on the outside of the drum is below 100°C;

b. in the case of totally enclosed brakes, including oil immersed brakes, the temperature measured on the outside of the housing is below 50°C; and

c. the brakes have not been actuated for one hour.

5.2.6.2.2 During the braking test, an unbraked axle, when capable of being declutched, shall not be connected with a braked axle.

5.2.6.2.3 The test shall be conducted under the following conditions:

a. the tractor shall be ballasted to its maximum mass with an unbraked axle also loaded to its technically permissible maximum mass; for tractors braking on all wheels, the front axle shall be laden to its technically permissible maximum mass;

b. the test shall be repeated on the unballasted tractor carrying only the driver and, if necessary, a person responsible for monitoring the results of the test; and

c. the road shall be level.

5.2.6.2.4 With the tractor traveling at its maximum speed or 50 ± 5 km/h, whichever is less, a measured force shall be applied to the control of the service braking device and the resulting stopping distance measured. Where possible the engine shall be declutched when starting to apply the brakes. If this is not possible, the engine speed control shall be moved to the minimum engine speed position. The stopping distance for a series of values of force applied to the control of the braking device shall be recorded and the corresponding values of mean deceleration calculated from the following formula:

$$f = V^2/2S,$$

where : **f** is the mean deceleration, m/s^2
V is the initial speed, m/s
S is the stopping distance, m

Sufficient values shall be obtained to establish the relationship between mean deceleration and force applied to the control of the braking device. The force shall vary between zero and, if possible**,** the force at which the brakes lock**.** If the brakes do not lock, the effect of forces up to 600 N shall be recorded. The relationship between mean deceleration and force applied to the control of the braking device shall be reported in the form of either a graph or a table of corresponding values. Deviation of the tractor from its original course and any abnormal vibration during braking shall also be reported.

5.2.6.3 Parking braking device test

The tractor shall be ballasted to its maximum weight. The force, which is necessary to apply at the control of the parking braking device to hold the tractor stationary when facing up and down an 18% gradient, shall be measured. The measurements may be made either on a sloping road or by applying a pull to the tractor on a level road.

If it is necessary to actuate the parking braking device control several times in order to hold the tractor stationary, the maximum force applied shall be recorded.

5.2.6.4 The items to be measured and recorded are given in Annex G.

5.3 Field Performance Test

5.3.1 This is carried out to test the field performance of the tractor under plowing or rotary tilling operations.

5.3.2 The test shall be carried out on a dry or wet field where the soil type, dimensions, soil moisture content, soil resistance, shape and other conditions are to be recorded.

5.3.3 Field operations

This shall be done for fields of not less than 2, 500 m^2 rectangular with sides in the ratio of 2:1 as far as possible with at least two replications The depth of tillage shall depend on the maximum recommended depth of cut of the implement to be used.

5.3.4 Field operational pattern

Field capacity and field efficiency are influenced by field operational pattern which is closely related to the size and shape of the field, the kind and size of implement. The non-working time should be eliminated as far as possible with adoption of appropriate field operational pattern for rectangular fields as shown in Figure 3. A combination of patterns may be adopted on small fields.

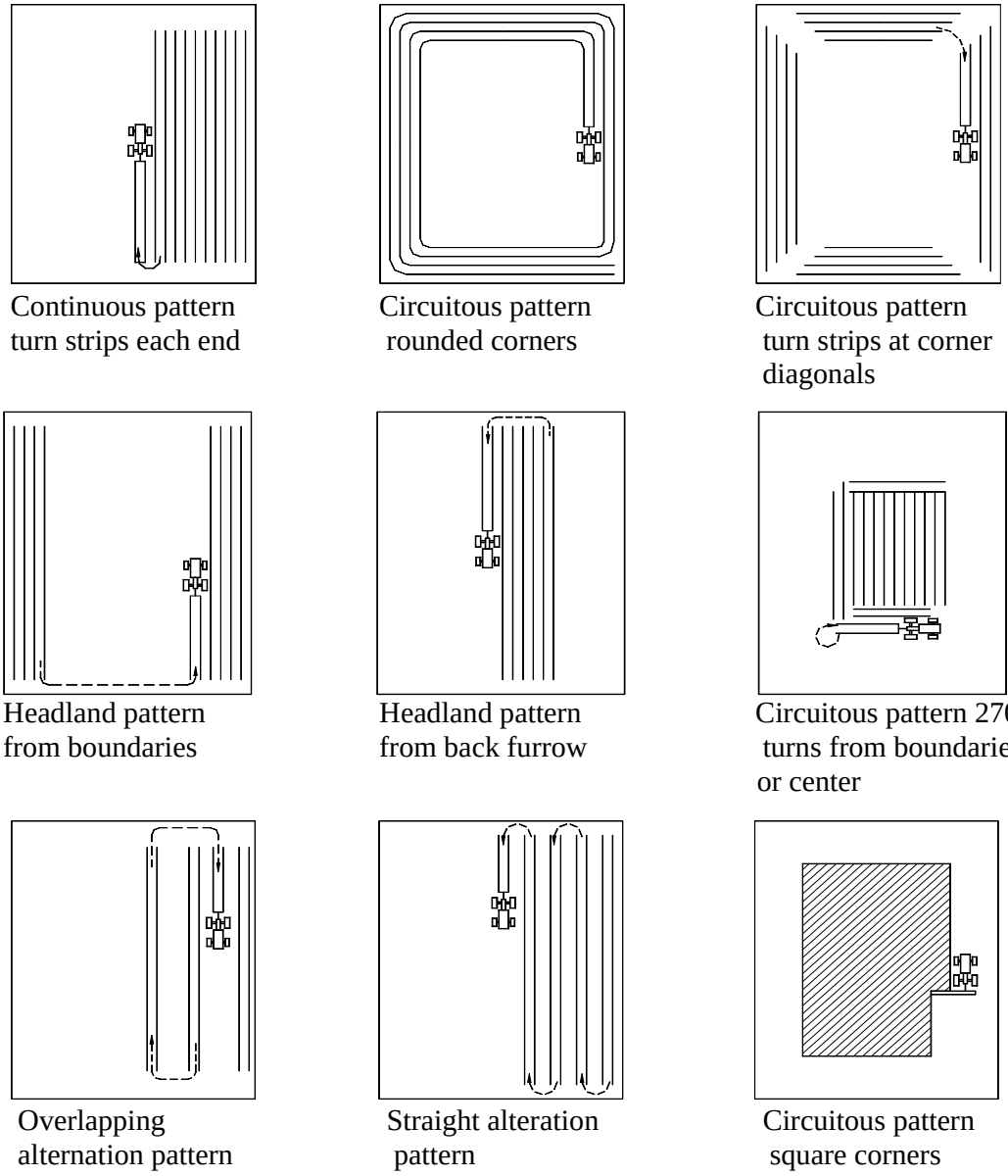

Figure 3 – Field Operational Patterns

5.3.5 Measurement

5.3.5.1 Operating speed

Outside the long boundary of the test plot, two poles 20 m apart (A, B) are placed approximately in the middle of the test run. On the opposite side also two poles are placed in similar position, 20 m apart (C, D) so that all four poles form corners of a rectangle, parallel to at least one long side of the test plot. The speed will be calculated from the time required for the machine to travel the distance (20 m) between the assumed line connecting two poles on opposite sides AC and BD. The easily visible point of the machine should be selected for measuring the time.

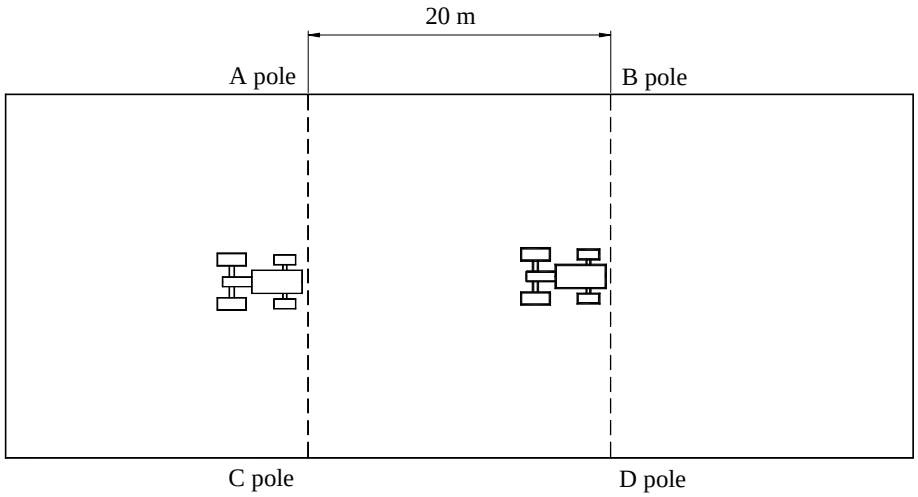

Figure 4 – Measurement of Operating Speed

5.3.5.2 Noise level measurement

5.3.5.2.1 The equipment shall be calibrated frequently and, if possible, before each measuring session. An adequate technical description of measuring equipment shall be given in the test report.

5.3.5.2.2 The noise emitted by the tractor measured 50 mm away from the operator's ear level shall not be more than 92 db (A).*

5.3.5.3 Fuel Consumption

The tank is filled to full capacity before and after each test trial. Amount of refueling after the test is the fuel consumption for the test. When filling up the tank, careful attention should be paid to keep the tank horizontal and not to leave empty space in the tank.

5.3.6 The items to be measured, investigated and recorded during the field performance tests are given in Annex G.

* Allowable noise level for six (6) hours of continuous exposure based on Occupational Safety and Health Standards, Ministry of Labor, Philippines. 1983.

6 Data Analysis

The formulas to be used during calculations and testing are given in Annex H.

7 Test Report

The test report shall include the following information in the order given:

7.1 Name of testing agency

7.2 Test report number

7.3 Title

7.4 Summary

7.5 Purpose and scope of test

7.6 Methods of test

7.7 Description of the four-wheel tractor

7.8 Results of Laboratory Tests

7.9 Results of Field Test

7.10 Observations

7.11 Name and Signature of Test Engineers

Annex A

Inspection Sheet for Four-Wheel Tractor

Name of Applicant : _____

Address : _____

Telephone No. : _____

Name of Distributor : _____

Address : _____

Name of Manufacturer : _____

Factory Address : _____

GENERAL INFORMATION

Brand :_____ Model :_____

Serial No. : _____Type : _____

Production date of tractor to be tested : _____

Items to be inspected

ITEMS	Manufacturer's Specification	Verification by Testing Agency
A1 Dimensions and weight of tractor		
A1.1 Overall length, mm		
A1.2 Overall width, mm		
A1.3 Overall height, mm		
A1.4 Dry weight of tractor, kg		
A1.4.1 Front		
A1.4.2 Rear		
A1.4.3 Total		
A2 Engine		
A2.1 Make/Country of Manufacture		
A2.2 Model		
A2.3 Serial Number		
A2.4 Type		
A2.4.1 Fuel used		
A2.4.2 Governor		
A2.4.3 Air cleaner		
A2.4.4 Lubrication system		
A2.4.5 Cooling system		

ITEMS	Manufacturer's Specification	Verification by Testing Agency
A2.4.6 Starting system		
A2.4.7 Electrical system		
A2.4.8 Exhaust system		
A3 Power take-off		
A3.1 Location		
A3.2 Type (1, 2 or 3)		
A3.2.1 Diameter of PTO shaft ends, mm		
A3.2.2 Number of splines		
A3.2.3 Rated shaft speed, rpm		
A3.4 Height above ground, mm		
A3.5 Direction of rotation (viewed from the rear of the tractor)		
A3.6 Mode of operation		
A4 Ground clearance, mm		
A5 Three-point linkage		
A5.1 Length of lift arms, mm		
A5.2 Length of lower links, mm		
A5.3 Horizontal distance between two lower links, mm		
A5.4 Horizontal distance between two lift arms endpoints, mm		
A5.5 Length of upper link, mm		
A6 Drawbar		
A6.1 Type (fixed, swinging or link)		
A6.1.1 Fixed drawbar		
A6.1.1 Swinging drawbar		
A6.1.1 Link drawbar		
A6.2 Drawbar hole diameter, mm		
A6.3 Drawbar thickness, mm		
A7 Transmission system		
A7.1 Main clutch and PTO clutch		
A7.1.1 Dry type single-plate clutch		
A7.1.2 Dual clutch		
A7.2 Transmission gears		
A7.2.1 Sliding mesh gears		
A7.2.2 Constant mesh gears		
A7.2.3 Synchronous mesh gears		
A7.2.3.1 Constant load type		
A7.2.3.2 Inertia lock type		

ITEMS	Manufacturer's Specification	Verification by Testing Agency
A7.2.4 Planetary gears		
A7.2.5 Fluid coupler and transmission		
A7.3 Differential gears		
A7.4 Differential lock		
A8 Tire		
A8.1 Front tire size		
A8.2 Rear tire size		
A8.3 Wheel base , mm		
A9 Brake system		
A9.1 Type according to manner of applying braking force		
A9.1.1 Internal expansion type		
A9.1.2 External contraction type		
A9.1.3 Disc type		
A9.2 Type according to manner of transmitting the force from the control		
A9.2.1 Mechanical brake		
A9.2.2 Hydraulic brake		

Annex B

Power-Take-Off Performance Test Data Sheet

Date and Location of tests: _____Type of dynamometer bench: _____

Power kW	Speed, rpm		Fuel consumption			Specific energy
	Engine	P.T.O.	Hourly		Specific	
			kg/h	L/h	g/kWh	kW-h/L
B1 Maximum power - Two-hour test						
B2 Power at rated engine speed						
B3 Standard power-take-off speed (1000 ± 25 or 540 ± 10 rpm)						
B4 Part loads						
B4.1 the torque corresponding to maximum power at rated engine speed						
B4.2 85 % of torque obtained in B4.1						
B4.3 75 % of torque defined in B4.2						
B4.4 50 % of torque defined in B4.2						
B4.5 25 % of torque defined in B4.2						
B4.6 unloaded						
B5 Part loads at standards power-take-off speed (1000 ± 25 or 540 ± 10 rpm)						
B5.1 the torque corresponding to maximum power						
B5.2 85 % of torque obtained in B5.1						
B5.3 75 % of torque defined in B5.2						
B5.4 50 % of torque defined in B5.2						
B5.5 25 % of torque defined in B5.2						
B5.6 unloaded						

No load maximum engine speed : _____rpm
Toque (equivalent crankshaft) at maximum power
At rated engine speed : _____N-m
At rated 2-hour test :_____N-m
Maximum torque (equivalent crankshaft): _____N-m
(engine speed:_____rpm)

Mean atmospheric conditions:	
Temperature	°C
Pressure	kPa
Relative humidity	%
Maximum temperatures:	
Coolant	°C
Engine oil	°C
Fuel	°C
Engine air intake	°C

Annex C

Hydraulic lifting force and power

Date of tests : _____

C1 Hydraulic lifting force test

C1.1 Three-point linkage

The linkage settings for test is illustrated in Figures 1C and 2C and Table 1C.

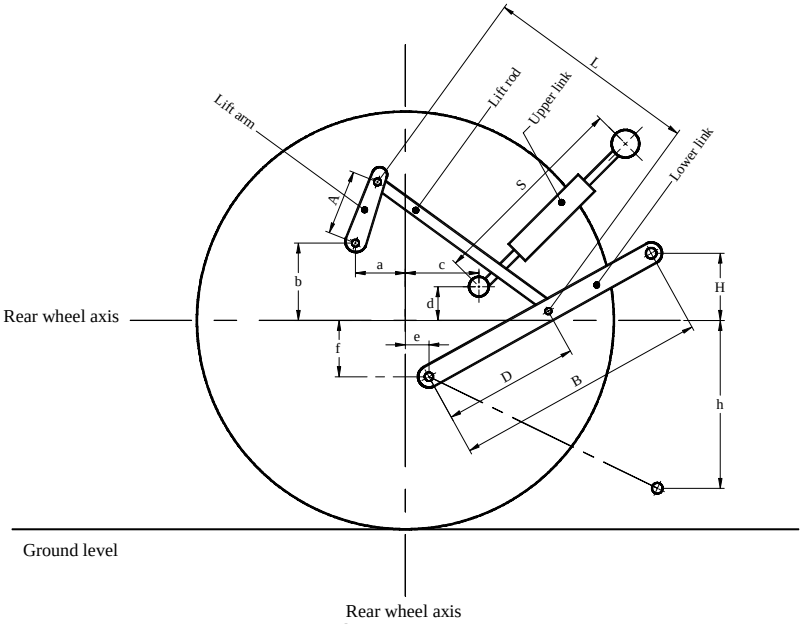

Figure C1 – Lift test - Linkage geometry

Note: Give detailed figures of power lift and complete Table 1C with values corresponding to the dimensions of the figure above

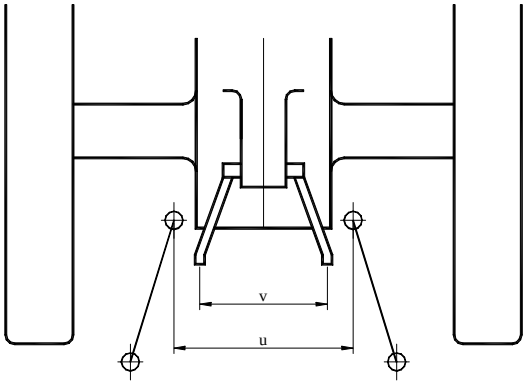

Figure C2 - Lift test - Linkage geometry

Note: Give detailed graph of power lift and complete Table 1C with values corresponding to the dimensions of the graph above

Table C1 - Dimensions of linkage geometry when connected to the standard frame

		Dimension or range mm	Settings used in test mm
Length of lift arms:	(A)		
Length of lower links:	(B)		
Distance of lift arm pivot point from rear-wheel axis :			
- horizontally	(a)		
- vertically	(b)		
Horizontal distance between the 2 lower link points:	(u)		
Horizontal distance between the 2 lift arm end points:	(v)		
Length of upper link:	(S)		
Distance of upper link pivot point from rear wheel axis :			
- horizontally	(c)		
- vertically	(d)		
Distance of lower link pivot point from rear wheel axis :			
- horizontally	(e)		
- vertically	(f)		
Distance of lower link pivot points to lift rod pivot points on lower links:	(D)		
Length of lift rods :	(L)		
Height of lower hitch points relative to the rear-wheel axis:			
- in low position	(h)		
- in high position	(H)		
Height above ground of lower hitch points when locked in transport position (*)			
(*) Assuming r = rear tire dynamic radius index of ISO 4251-1 (pneumatic tire tractors only)			

C1.2 Power lift test

Table C2 – Power Lift Test Data Sheet

	at the hitch point	on the frame
Height of lower hitch points above ground in down position, mm		
Vertical movement, mm		
Maximum corrected force exerted through full range, kN		
Corresponding pressure of hydraulic fluid, MPa		
Moment about rear-wheel axis, kN-m		
Maximum tilt angle of mast from verical, degrees		

Lifting heights relative to the horizontal plane including the lower link pivot points									
mm	**-**	**-**	**-**	**-**	**0**	**+**	**+**	**+**	**+**
Lifting forces (the values of force measured shall be corrected to correspond to a hydraulic pressure equivalent to 90 % of the actual relief valve pressure setting of the hydraulic lift system):									
at the hitch points in kN:									
Corresponding pressure: _____MPa									
at the frame in kN:									
Corresponding pressure: _____MPa									

C2 Hydraulic power test

Sustained pressure with relief valve open:
_____MPa
Pump stalled: _____Yes / _____No
Pump delivery rate at minimum pressure : _____L/min

Table C3 – Hydraulic Power Test Data Sheet

	Flow rate	Pressure	Power
	L/min	MPa	kW
Flow rate corresponding to a hydraulic pressure equivalent to 90 % of the actual relief valve pressure setting and corresponding hydraulic power			
Flow rate and hydraulic pressure corresponding to maximum hydraulic power			

Tapping point used for test:
Temperature of hydraulic fluid, if different from 65 ± 5°C: _____°C
Opening pressure of the unloading valve: _____MPa
Closing pressure of the unloading valve: _____MPa

Annex D

Drawbar Power Test Data Sheet

Date of tests: _____Type of track:_____

	Height of drawbar above ground, mm	Tire inflation pressure, kPa	
		Front	Rear
Unballasted			
Ballasted			

Gear number and range	Power	Drawbar pull	Speed	Engine speed	Slip of wheels and/or tracks	Specific fuel consumption	Specific energy	Temperature			Atmospheric conditions		
								Fuel	Coolant	Engine oil	Temperature	Relative humidity	Pressure
	kW	kN	km/h	rpm	%	g/kWh	KW-h/l	°C	°C	°C	°C	%	kPa
D1 Maximum Power in Tested Gears (unballasted tractor)													
D2 Maximum Power in Tested Gears (ballasted tractor)													
D3 Five-hour Tests													
D3 .1 Five-hour Test at 75% of the pull corresponding to maximum power at rated speed													
D3 .2 Five-hour Test at pull corresponding to 15% wheelslip *(trackslip: ≥ 7%),* with additional ballast : _____ kg													
					(*)	(*)							
D4 Five-hour Test at 75% of the pull corresponding to maximum power at rated speed (track laying tractors)													

(*)Those figures not quoted are irrelevant due to the additional ballast.

Oil consumption during ten hours duration of: _____g/h

D5 In case of tracklaying tractors, the following table will be used:

	Ballasted	Unballasted
Maximum drawbar pull	kN	kN
Slip corresponding To 7 %	%	%
	kN	kN

Annex E

Turning Area and Turning Circle Data Sheet

	With Brakes		Without Brakes	
	Right turn	**Left turn**	**Right turn**	**Left turn**
Radius of turning area, mm				
Radius of turning circle, mm				

Annex F

Location of Center of Gravity Data Sheet

Height above ground:_____mm

Distance from the vertical plane containing the axis of the rear-wheels:_____mm

Distance from the median longitudinal plane of the tractor: _____mm

If the angle of suspension of the tractor is less than 20°, indicate its value: _____°

Annex G

Field Performance Test Data Sheet

Items to be Measured and Inspected

ITEMS	Trials			Average
	1	2	3	
G1 Test Conditions				
G1.1 Condition of field				
G1.1.1 Location				
G1.1.2 Dimensions of field (L x W), m				
G1.1.3 Area, m^2				
G1.1.4 Soil type (clay, clay loam, sandy, etc)				
G1.1.5 Moisture content, %				
G1.1.6 Weed density (low, medium, or high)				
G1.1.7 Soil resistance, kg/cm^2				
G1.1.8 Last crop planted				
G1.2 Weather conditions				
G1.2.1 Temperature				
G1.2.1.1 Wet bulb, ºC				
G1.2.1.2 Dry bulb, ºC				
G1.2.2 Weather (sunny, cloudy, rainy, hot, cold..)				
G1.3 Condition of the tractor				
G1.3.1 Tractive device				
G1.3.1.1 Type				
G1.3.1.2 Size				
G1.3.2 Wheel tread				
G1.3.3 Additional weight, kg				
G1.3.3.1 Front-end				
G1.3.3.2 Wheel				

ITEMS	Trials			Average
	1	2	3	
G1.3.4 Gross weight, kg				
G1.3.5 Speed-gear positions				
G1.3.5.1 Main transmission				
G1.3.5.2 Auxiliary transmission				
G1.3.5.3 Rotary speed change				
G1.3.6 Others				
G2 Field Performance				
G2.1 Date of test				
G2.2 Kind of field operation				
G2.3 Type and size of implement				
G2.4 Depth of cut, mm				
G2.5 Traveling or operating speed, km/h				
G2.6 Theoretical width of tillage, mm				
G2.7 Actual width of tillage, mm				
G2.8 Time lost, min				
G2.8.1 Turning, min				
G2.8.2 Others (specify), min				
G2.9 Duration of test, min				
G2.10 Actual field capacity, ha/h				
G2.11 Theoretical field capacity, ha/h				
G2.12 Field efficiency, %				
G2.13 Noise level, db(A)				
G2.14 Wheel slip or travel reduction, %				
G2.15 Fuel consumed, L				
G2.16 Fuel consumption, L/h				
G2.17 Others (specify)				
G3 Observations:				
G3.1 Ease of handling and stability of the tractor				
G3.2 Ease of manipulating of the operating levers				
G3.3 Ease of replacing and adjusting the parts				
G3.4 Safety features				
G3.5 Failure or abnormalities that may be observed on the tractor or its component parts				
G3.6 Others				

Annex H

Formulas Used During Calculations and Testing

H1 Field Performance Test

H1.1 Estimation of Effective Field Capacity

H1.1.1 Average swath or width of cut, *S*, (m)

$$S = \frac{W}{2n}$$

where: W is the width of plot, m
n is the number of rounds
2 is the number of trips per round

H1.1.2 Total distance traveled, *D*, (m)

$$D = \frac{A}{S} = 2nL$$

where: A = L x W

where: A is the area of plot, m^2
L is the length of the plot, m

H1.1.3 Effective area accomplished, A_e, (m^2)

$$A_e = wD = 2nLw$$

where: w is the width of plow or rotary tiller, m

H1.1.3.1 If width of swath is less than the plow's or rotary tiller's width, the operator has passed over part of the area twice to secure better coverage, therefore:

$$A_o = A_e - A$$

where: A_o is the overlap (area which is plowed or rototilled twice), m^2

H1.1.3.2 If the average width of swath is greater that the plow's or rotary tiller's width, the operator has left part of the area unplowed or unrototilled, therefore:

$$A_u = A - A_e$$

where: A_u is the unplowed or unrototilled area (area missed), m^2

H1.1.4 Effective field capacity, *efc*, (m^2/h)

$$efc = \frac{60A_e}{t}$$

where: t is the time used during the operation, min

H1.2 Theoretical Field Capacity, *tfc*, (m^2/h)

$$tfc = w_e \; x \; v$$

where: w_e is the effective or theoretical width of tillage, m
v is the speed of operation, m/h

H1.3 Field Efficiency, ε_f, (%)

$$\varepsilon_f = \frac{efc}{tfc} \quad x \quad 100$$

H1.4 Wheel slip, %

$$Wheel\ slip, \% = \frac{N_1 - N_0}{N_1} \; x \; 100$$

where:

N_1 is the sum of the revolutions of all driving wheels for a given distance with slip, rpm

N_0 is the sum of the revolutions of all driving wheels for the same distance without slip, rpm

H1.5 Fuel Consumption, F_c, (L/h)

$$F_c = \frac{V}{t}$$

where: V is the volume of fuel consumed, L
t is the total operating time, h

H2 Laboratory Tests

H2.1 Axle/Rotary Shaft Torque, *T*, (kg-m)

$$T = F \quad x \quad L$$

where: F is the axle or rotary shaft load, kg
L is the length of pony brake arm, m

H2.2 Axle/Rotary Shaft Power, *P*, (kW)

$$P = \frac{F_t \; x \; N}{1340}$$

where: F_t is the total axle or rotary shaft load, kg
N is the speed of axle or rotary shaft, rpm

H2.3 Specific Fuel Consumption, *SFC*, (g/kW-h)

$$SFC = \frac{F_c \quad x \quad \rho_f}{P}$$

where: F_c is the fuel consumption, L/h
ρ_f is the density of fuel, g/L
P is the axle or rotary shaft power, kW