

PHILIPPINE NATIONAL STANDARD

PNS/BAFS PABES 302:2020
ICS 65.060.10

Production Machinery – Four-Wheel Tractors – Methods of Test



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Foreword

The Philippine National Standard (PNS) for Agricultural Machinery – Four-Wheel Tractors – Methods of Test (PNS/BAFS PABES 302:2020) was developed by the Bureau of Agriculture and Fisheries Standards (BAFS) as per the request of Task-Force PAES of the Philippine Council for Agriculture and Fisheries (PCAF). It has been prepared by the Technical Working Group (TWG) for the revision of PAES for Four-Wheel Tractors and Walking-Type Agricultural Tractors per approved Department of Agriculture Special Order No. 290 series of 2017.

In the development of the Standard, some provisions were adopted from the OECD Standard Codes for the Official Testing of Agricultural and Forestry Tractors.

This Standard includes the following significant changes compared to the previous edition:

- Deletion of “test at full load and varying speed”, “test at varying load”, “position of center of gravity”, and “field performance of the machine” in the scope of the standard
- Inclusion of “wheelbase” and “hydraulic lift force” in Clause 3
- Modifications on figures for the dimension of four-wheel tractors in Clause 3
- Deletion of formula in the definition of “wheel slip”
- Inclusion of figure for “wheelbase” in Clause 3
- Revisions on the provision for “General Conditions for Test”.
- Inclusion of provision for “Test Preparation” as Clause 5
- Renaming of the clause title from “Test and Inspection” to “Pre-test Observations” and revision of the provisions under it
- Deletion of provisions for “test at full load and varying test”, “test at varying load”, “ten-hour test for the special case of track laying tractors”, “position of center of gravity”, and “field performance test” as part of Performance Test
- Harmonization of the format and other general provisions with other approved PNS
- Inclusion of list of test equipment and materials as Annex A
- Renaming of Annex for “Inspection Sheet for Four-Wheel Tractor” to “Specifications of Four-Wheel Tractor”
- Inclusion of “Operator’s Manual, Tractor Safety, Workmanship and Finish” as Annex C
- Revision of Annexes for “PTO Performance Test Data Sheet” and “Hydraulic Lifting Force and Power” based on the changes in the provisions for “Performance Test”
- Deletion of Annexes for “Location of Center of Gravity” and “Field Performance Test Data Sheet”
- Revisions on the Annex for “Formula Used During Calculations and Testing”

This Standard cancels and replaces the provisions recommended by PAES 119:2001 – Agricultural Machinery – Four-Wheel Tractors – Methods of Test.

This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2.

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 performance requirements specified in PNS/BAFS PABES 301:2020 and the specifications submitted by the manufacturer;

1.2 determine the laboratory performance of the four- wheel tractor;

1.2.1 power-take-off (PTO) performance test

1.2.1.1 maximum power test

1.2.1.2 test at full load and varying speed

1.2.2 hydraulic power test and lifting force test

1.2.3 drawbar power test – ballasted and unballasted tractor

1.2.4 turning area and turning circle

1.2.5 braking test

1.3 prepare a report on the results of the tests

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this documents. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAES 103:2000, *Agricultural Machinery – Method of Sampling*

PAES 301:2020, *Agricultural Machinery – Four-Wheel Tractor – Specifications*

ISO 730:2009, *Agricultural Wheeled Tractors- Rear-mounted three-point linkage – Categories 1N, 1, 2N, 2, 3N, 3, 4N and 4*

3 Terms and Definition

For the purpose of this standard, the following terms and definitions given in PNS/BAFS PABES 301:2020 and the following shall apply.

3.1

ballast

any material added to the four-wheel tractor for the purpose of enhancing traction or stability

3.2

engine rated power

maximum power at rated speed measured at the flywheel or the crankshaft

3.3

engine rated speed

speed in revolutions per minute specified by the manufacturer

3.4

four-wheel tractor weight

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

3.5

ground clearance

perpendicular distance between the ground and the lowest point of the four-wheel tractor

3.6

hydraulic lift force

maximum vertical lifting force on the lower links of the four-wheel tractor

3.7

maximum drawbar pull

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

3.8

overall height

distance between the ground and the horizontal plane touching the uppermost part of the four-wheel tractor as shown in Figure 1

3.9

overall length

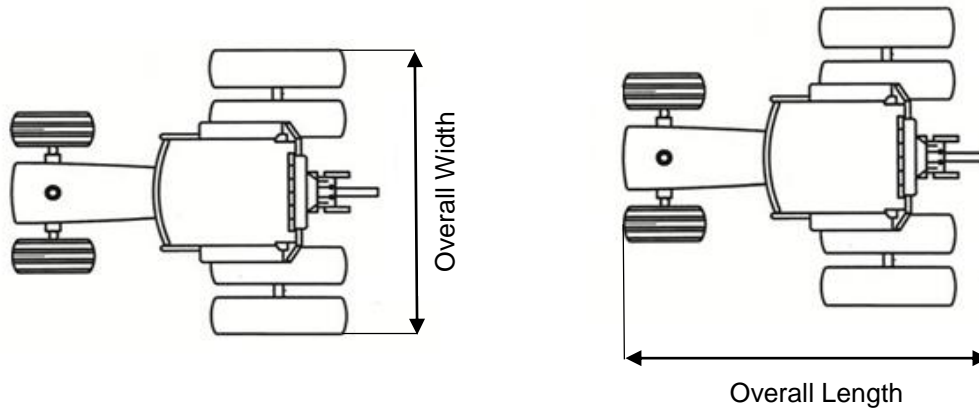
distance between the two vertical planes at right angles to the median plane of the four-wheel tractor and touching its front and rear extremities as shown in Figure 1

3.10

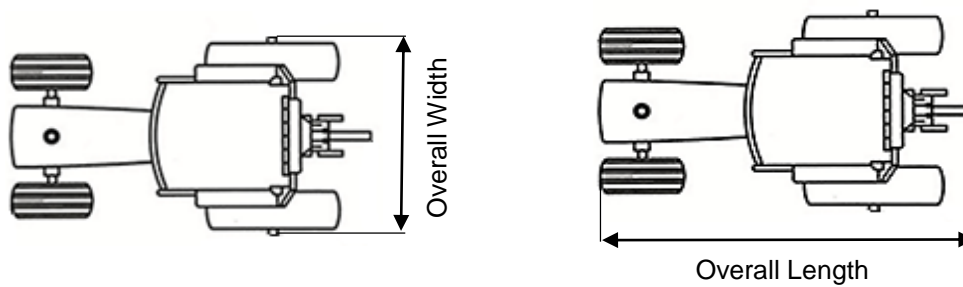
overall width

distance between two vertical planes parallel to the median plane of the four-wheel tractor, each plane touching the outermost point of the four-wheel tractor on its respective side as shown in Figure 1

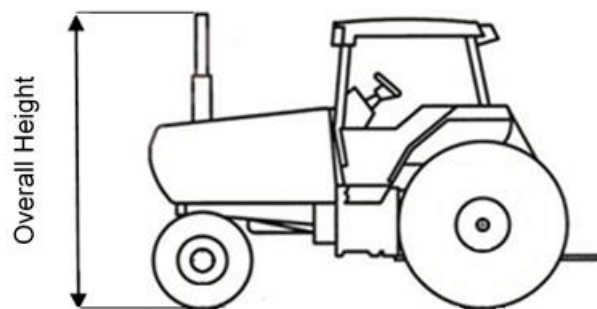
NOTE All parts of the tractor, particularly all fixed components projecting in lateral position (i.e. wheel hubs), are contained between these two planes.



a) double rear wheel overall width and length



b) single rear wheel overall width and length



c. overall height

Figure 1 – Dimension of four- wheel tractor

3.11

radius of turning area

radius of clearance circle

radius of the smallest circle described by the outermost point of the four-wheel tractor as shown in Figure 2

3.12

radius of turning circle

radius of the smallest circle tangentially described by the median plane of the outermost wheel of the four- wheel tractor as shown in Figure 2

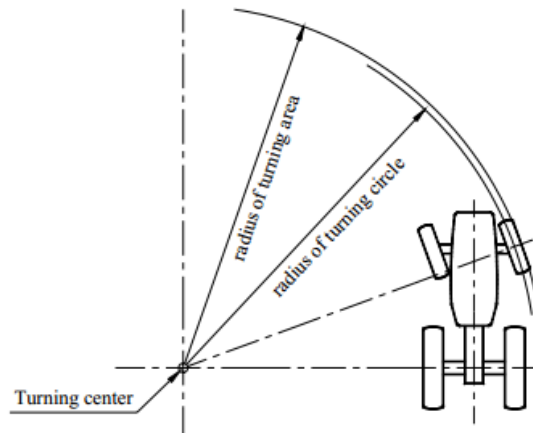


Figure 2 – Radius of turning area and radius of turning circle

3.13

specific fuel consumption

mass of fuel consumed per unit of work

3.14

wheelbase

horizontal center to center distance between the front and rear wheel axles as shown in Figure 3

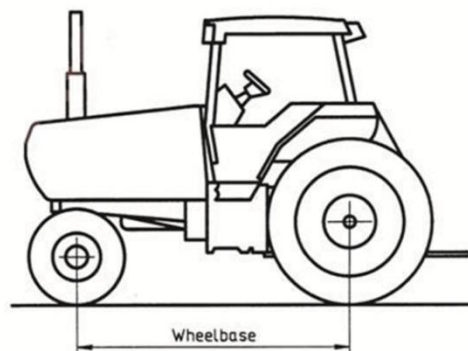


Figure 3 – Four-wheel tractor wheelbase

3.15

wheel slip

travel reduction of the drive wheels for a given drawbar load

4 General Conditions for Test

4.1 Selection of tractor to be tested

Four-wheel tractors submitted for testing shall be sampled in accordance with PAES 103:2000 or any other suitable method of selection.

4.2 Role of test applicant

The test applicant shall submit specifications and other relevant information about the four-wheel tractor. They shall abide with the terms and conditions set forth by the official testing agency.

4.3 Role of the official representative of the test applicant

An officially designated representative of the test applicant shall operate, demonstrate, adjust, repair as the case maybe, and decide on matters related to the operation of the machine.

4.4 Running-in and preliminary adjustments

The four-wheel tractor shall have undergone a running- in period before the start of the test. During the running- in period, various adjustments of the machine shall be made according to the recommendation of the test applicant. If this procedure is impractical due to the four-wheel tractor being an imported model, the official testing agency may itself run in the four-wheel tractor provided that the authority of the test applicant or his representative is obtained.

4.5 Fuels and lubricants

Fuels and lubricants shall be selected from the range of products commercially available in the country.

4.6 Test site conditions

The four-wheel tractor shall be tested for normal operation. The site should be suitable for normal working condition and should have ample provisions for workspace. Adequate ventilation and lighting shall be provided in the area.

4.7 Repairs during test

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

4.8 Suspension/termination of test

If during the test run, the four-wheel tractor stops due to breakdown or malfunction so as to affect the machine's performance, the test may be suspended. If the four-wheel tractor will not be able to continue operation, the test shall be terminated.

5 Test Preparation

5.1 Preparation of the tractor for testing

The officially designated representative of the test applicant and the official testing agency shall check the four-wheel tractor so as to ensure that it has been assembled in accordance with the instruction of the manufacturer.

5.2 Test instruments and other materials

The suggested list of minimum test equipment and materials needed to carry out the four-wheel tractor test is shown in Annex A. The measuring instruments to be used shall be checked and calibrated by the official testing agency prior the conduct of the test. The items to be measured shall have minimum scale of accuracy as shown in Table 1.

Table 1 – Minimum Scale of Accuracy for Different Parameters

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

6 Pre- test Observations

6.1 Verification of specifications

The specifications claimed by the manufacturer and the physical details given in Annex B shall be verified by the official testing agency. A stable and level surface shall be used as reference plane for verification of dimensional specifications.

6.2 Operator's manual and safety, workmanship, and finish

The official testing agency shall verify the provisions for machine safety, workmanship, and finish as provided in PNS PABES 301:2020 and shall check the content of the operator's manual, as provided in Annex C. Operator's manual shall be from the Original Equipment Manufacturers (OEM).

7 Performance Test

7.1 PTO performance test

The items to be measured and recorded for PTO performance test are given in Annex D.

7.1.1 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 shall not change the engine performance.

7.1.2 Maximum power test

With the governor control set for maximum power at rated speed, 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.

7.1.3 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 of at least 15% below the speed on which maximum torque occurs or to an engine speed of 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 test applicant in agreement with the testing station.

7.2 Hydraulic power and lifting force

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

7.2.1 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 730:2009. 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 that are 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 that are 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.

7.2.2 Lifting force

7.2.2.1 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 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. In addition, the range of movement shall be reported. The pressure recorded during the test shall exceed the minimum relief valve pressure setting. The relief valve pressure setting shall be as specified by the manufacturer.

7.2.2.2 Lift on a coupled frame

A frame with 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 four-wheel tractor shall be appropriate to the linkage category. If there are more than one category specified, the choice for the test shall be at the manufacturer's option.
- b. The center of gravity shall be at a point of 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 specified in Clause 7.2.2.1 The weight of the frame shall be added to the force applied.

7.2.3 Hydraulic power

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

- a. The pressure sustained by the open relief valve and 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.

7.3 Drawbar power- ballasted and unballasted tractor

7.3.1 Test conditions

During all the tests at the drawbar, the governor control shall be set to maximum power. Tests shall not be made in gears in which the forward speed will exceed the safety limits of the testing equipment.

For each gear, at the speed and pull giving maximum power in that gear, 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 shall be recorded.

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

In case of wheeled tractors, performance values of up to 15% mean wheel slip shall be reported. As the non-slip distance varies according to the degree of wear of the tires, it is necessary to check it regularly, particularly before determining the maximum drawbar power. With track-laying tractors, the maximum drawbar pull, together with the corresponding track slip, and the point corresponding to a track slip of 7% or more, shall be stated as a footnote under the table giving drawbar power values.

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.

7.3.2 Test track

The tests at the drawbar shall be conducted by the in accordance with the following conditions:

- a. The tests shall be carried out on a clean, horizontal, and dry concrete or tarmac surface containing a minimum number of joints.
- b. Tractors that are not suitable for operation on concrete or tarmac 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.

- c. 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.
- d. The type of test track shall be clearly stated in the report.

7.3.3 Drawbar

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 shall be selected so as to keep adhesion consistent between front and rear wheels when the drawbar pull reaches maximum.

7.3.4 Tread bar height

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 using a three-point gauge. The gauge shall be placed across the tread bar and perpendicular to the direction of the tread bar. It shall be 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 body 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 around 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.

7.3.5 Steplessly variable/ fully automatic

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

Table 2 – Speeds for Deriving Power Values

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, the following data derived from the curve shall be reported:

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

7.3.6 Ballasting

Ballast weights may be fitted. For four- wheel 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. Irrespective of tire sizes, the four- wheel tractor should be ballasted with 60% of the weight distributed over the front axle and 40% over the rear axle.

7.4 Drawbar power test for 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.

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

7.5 Drawbar power test for 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.

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

7.6 Five-hour test

7.6.1 Tractors, ballasted as for Clause 7.3.3, will be tested for 5 hours in the gear and speed designated by the test applicant, in agreement with the official testing agency. This speed shall be the one normally used for basic agricultural work such as plowing but as far as possible from a different gear group from that used in Clause 7.3.4.b 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 the 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 stated separately.

7.6.2 Following test in 7.3.2.a, with a cooling interval between, tractors will be tested further for five hours at the drawbar pull giving at most 15% wheel slip measured during test in Clause 7.3.3. 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 have proper control of the tractor, within the load limitations specified by the test applicant 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 Clause 7.3.4.a.

7.6.3 During the ten hours of these two tests, the engine lubricating oil consumption shall be measured and expressed in units of mass per hour (m/hr). The items to be measured and recorded are given in Annex F.

7.7 Turning area and turning circle

7.7.1 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.

7.7.2 Test procedure

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

Measurements on four-wheel-drive tractor whose front-wheel-drive can be disengaged shall be performed 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 the 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 G.

7.8 Braking Test

Braking test should be performed during tractor test. This test may be omitted for track laying tractors which are not suitable for operation on the road.

7.8.1 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 test shall be conducted in a dry, concrete/asphalt, level road.
- b. The tractor mass shall be as prescribed for each type of test and be specified in the test report;
- c. The braked axle wheels shall be fitted with the highest load capacity tires used in normal agricultural work;
- d. The road shall have a surface affording good adhesion;
- e. The test shall be performed when there is no wind liable to affect the results;
- f. 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

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.

7.8.2 Cold service braking device test

The brakes shall 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.

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

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;
- b. For tractors braking on all wheels, the front axle shall be laden to its technically permissible maximum mass;
- c. 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
- d. The road shall be level.

With the tractor traveling at maximum speed or 50 ± 5 km/hr, whichever is less, a measured force shall be applied to the control of the service braking device and the resulting stopping distance measured.

If 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 and the corresponding values of mean deceleration shall be recorded and calculated.

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 with corresponding values. Deviation of the four-wheel tractor from its original course and any abnormal vibration during braking shall also be reported.

7.8.3 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.

7.9 Noise level

The noise emitted by the four-wheel tractor during drawbar power test shall be measured using a sound level meter at the location of the operator/s. The noise level, expressed in decibel [dB (A)], shall be measured 50 mm away from the ear level of the operator/s.

8 Presentation of Results

Machine specifications and the results of the test shall be presented in tabular form in which data shall be taken from Annexes B, D, E and F.

9 Formula

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

10 Test Report

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

10.1 Title

10.2 Summary of Results (including the performance compared with the criteria)

10.3 Purpose and Scope of Test

10.4 Methods of Test

10.5 Conditions of the Machine

10.6 Description of the Machine

10.7 Results and Discussions

10.8 Observations (include pictures)

10.9 Names and Signatures of Test Engineers

Annex A
(informative)

**Minimum List of
Test Equipment and Materials**

Table A.1 – Equipment and Materials Used for Testing

No.	Test Equipment and Materials	QUANTITY
A.1	Power Measurement	
A.1.1	Dynamometer (with shaft speed measurement)	
A.1.1.1	Prony brake (14.9 kW maximum)	Option 1
A.1.1.2	Electro brake (89.5 kW maximum)	Option 2
A.1.1.3	Water brake (149 kW maximum)	Option 3
A.2	Fuel Consumption gage	
A.2.1	Mechanical type	Option 1
A.2.2	Electronic type	Option 2
A.3	Hydraulic lift measurement	
A.3.1	At least 5 ton Load cell with display	1
A.3.2	610 mm length frame with three-point hitch	1
A.4	Speed and Turning Radius Measurement	
A.4.1	Steel tape, 5m and 100 m	1 each
A.5	Stop watch	2
A.6	Thermo-Hygrometer/Psychrometer	1
A.7	Camera	1
A.8	Protractor	1
A.9	Exhaust gas analyzer	1

Annex B
(informative)

Specifications of Four- Wheel Tractors

Name of Applicant : _____
 Address : _____
 Tel. No. : _____

Name of Manufacturer : _____
 Address : _____
 Tel. No. : _____

GENERAL INFORMATION

Make : _____ Type : _____
 Serial No. : _____ Brand/Model : _____
 Date of Manufacture: _____
 Testing Agency : _____ Test Engineer: _____
 Location of Test : _____ Date of Test : _____

Table B.1 – List of Four-Wheel Tractor Specifications for Verification

No.	Item*	Manufacturer's Specification	Verification by the Testing Agency
B.1	Dimensions and weight of tractor		
B.1.1	Overall length (mm)		
B.1.2	Overall width (mm)		
B.1.3	Overall width (mm)		
B.1.4	Dry weight of tractor (kg)		
B.1.4.1	Front axle		
B.1.4.2	Rear axle		
B.2	Engine		
B.2.1	Make/Country of Manufacture		
B.2.2	Model		
B.2.3	Serial Number		
B.2.4	Type		
B.2.4.1	Fuel used		
B.2.4.2	Governor		
B.2.4.3	Air cleaner		
B.2.4.4	Lubrication system		
B.2.4.5	Cooling system		
B.2.4.6	Starting system		
B.2.4.7	Electrical system		
B.2.4.8	Exhaust system		
B.2.5	Rated speed (rpm)		
B.2.6	Bore x Stroke (mm)		

Table B.1 Continued

B.2.7	Displacement (cc)		
B.3	Power take-off		
B.3.1	Location		
B.3.2	Type (1, 2, 3 or 4)		
B.3.2.1	Diameter of PTO shaft ends, mm		
B.3.2.2	Number of splines		
B.3.2.3	Rated shaft speed (rpm)		
B.3.3	Height above ground (mm)		
B.3.4	Direction of rotation (viewed from the rear of the tractor)		
B.3.5	Mode of operation		
B.3.5.1	Speed change (540, neutral, 1000, etc.)		
B.3.5.2	Clutch (independent, dual)		
B.4	Ground clearance (mm)		
B.5	Three-point linkage		
B.5.1	Length of lift arms (mm)		
B.5.2	Length of lower links (mm)		
B.5.3	Horizontal distance between two lower links (mm)		
B.5.4	Horizontal distance between two lift arms endpoints (mm)		
B.5.5	Length of upper link (mm)		
B.6	Drawbar		
B.6.1	Type (fixed, swinging or link)		
B.6.2	Drawbar hole diameter (mm)		
B.6.3	Drawbar thickness (mm)		
B.6.4	Category		
B.7	Transmission system		
B.7.1	Main clutch(Dry single plate, dual)		
B.7.2	Transmission gears (Sliding, constant mesh, Synchronous, and Automatic)		
B.7.3	Range gear		
B.7.4	Main gear		
B.7.5	Synchro-shuttle (if any)		
B.7.6	Differential gears		
B.7.7	Differential lock		
B.8	Tire		
B.8.1	Front tire size (mm)		
B.8.2	Rear tire size (mm)		
B.8.3	Wheel tread (mm)		
B.8.4	Front tread		
B.8.5	Rear tread		
B.8.6	Wheel base (mm)		
B.9	Brake system		

Table B.1 Continued

B.9.1	Type according to manner of applying braking force (Internal expansion, External contraction, Disc type)		
B.9.2	Type according to manner of transmitting the force from the control (Mechanical, Hydraulic)		

Annex C
(informative)

Operator's Manual, Tractor Safety, Workmanship and Finish

Table C.1 – Minimum Content of Operator's Manual

No.	Mandatory Provisions of PAES 102:2000	Observations
C.1.1	Operator's manual have its own part number and date of issue	
C.1.2	Section that provides information that will enable the operator to locate and identify the whereabouts of serial numbers and/or codes of the major components of the machine	
C.1.3	Introduction is included in the OM stressing the importance of the information given in the manual.	
C.1.4	Attention is drawn to the use of safety alert symbol to highlight information about potential dangers to the user.	
C.1.5	Content list is provided to identify the main categories of information in the manual and where they can be found. Location: Right-hand page	
C.1.6	Safety signs that appear on the machinery are reproduced in legible size in the operator's manual.	
C.1.6.1	Location of each safety sign on the machine	
C.1.6.2	Instructions on the need to keep safety signs clear and visible on the equipment	
C.1.6.3	Instructions to replace safety signs if they are missing or illegible	
C.1.6.4	Instructions that new equipment components installed during repair shall include the current safety signs specified by the manufacturer and shall be affixed to the replacement component	
C.1.6.5	Instructions on how to obtain replacement safety signs	
C.1.7	Operating information with logical instructions for effective operation of the machinery.	
C.1.8	Authorized accessories and attachments and its affect in safety, operation and maintenance	
C.1.9	Maintenance instructions and schedules are provided	
C.1.10	Instructions and information regarding the proper storage of the machinery including precautions to be taken and any tools or special equipment required to prepare the machinery for storage.	

Table C.1 Continued

C.1.11	Technical information and instructions for handling, reception, transportation, assembly, installation and initial set-up of the machinery	
C.1.12	Relevant dimensions and technical data necessary to assist the operator achieve a higher standard of operational performance and reliability (Specifications of the machinery)	
C.1.13	Action to be taken on the completion of the useful life of the machine or its parts, with instructions on dismantling and disposal.	
C.1.14	Parts list is included within the operator's manual (if there is no separate parts list or catalogue exists)	
C.1.15	Manuals are available in the language of each country where the machine is sold (Filipino or English)	
C.1.16	Consistent forms of language, spelling, numbering, symbols, etc. are used throughout the manual	
C.1.17	All numbers are written in Arabic numerals	
C.1.18	Title and number are provided for each table.	
C.1.19	Illustrated parts catalogue and repair manual	
C.1.20	Specific parts covered by warranty	

Table C.2 – Machine safety, workmanship, and finish

No.	Provision	Observations
C.2.1	Equipped with ROPS and seatbelt	
C.2.2	PTO shaft cover or casing	
C.2.3	Engine cooling system	
C.2.4	Mechanism to reduce vibration	
C.2.5	Labels, safety symbols, and warnings	
C.2.6	Heat shield or protective cover for hot surfaces that are in contact with the operator	
C.2.7	Provision for attachment of ballast or other weights	

Annex D
(informative)

Power-Take-Off Performance Test Data Sheet

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

Table D.1 – Data Sheet for the Determination of PTO Performance

Power kW	Speed, rpm		Fuel Consumption			Specific energy kW-h/L
	Engine	PTO	Hourly		Specific g/kW-h	
			Kg/h	L/h		
D.1 Power at rated engine speed						
D.2 Test at full load and varying speed						
D.3 Power at standard PTO speed						

No load maximum engine speed: _____rpm

Torque (equivalent crankshaft torque) at maximum power

At rated engine speed : _____N-m

At rated 2 -hour test : _____N-m

Maximum torque (equivalent crankshaft torque): _____ N-m

(engine speed: _____rpm)

Table D.2 – Mean Atmospheric Conditions Per Trial

Mean atmospheric conditions:	Trial 1	Trial 2	Trial 3
Temperature (°C)			
Pressure (kPa)			
Relative Humidity (%)			
Maximum Temperatures			
Coolant (°C)			
Engine oil (°C)			
Fuel (°C)			
Engine air intake (°C)			

Annex E
(informative)

Hydraulic power and lifting force

Date of tests: _____

E.1 Hydraulic lifting force test

E.1.1 Three-point linkage

The linkage settings for test are illustrated in Figures E.1 and E.2 and Table E.1.

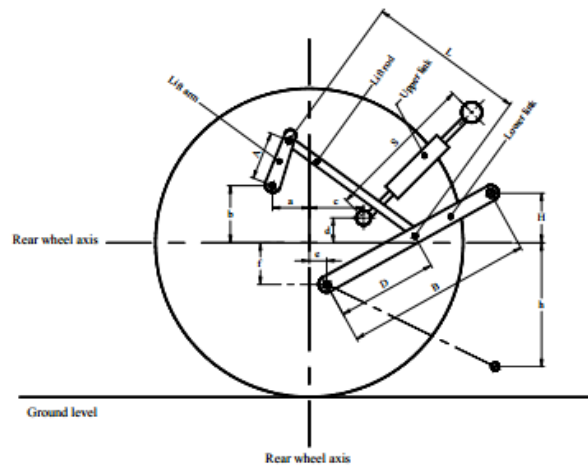


Figure E.1 – Lift test- Linkage geometry

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

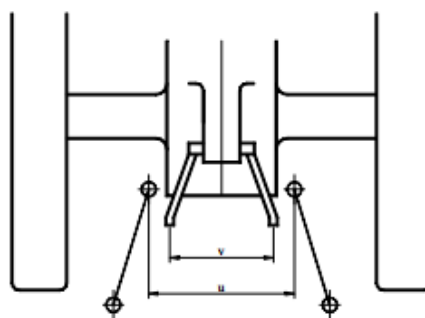


Figure E.2 – Lift test- Linkage geometry

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

Table E.1. – 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 and 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)			

E.1.2 Power lift test

Table E.2 – 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 vertical, degrees		

Table E.2 Continued

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									

E.2 Hydraulic power test

Sustained pressure with relief valve open: _____MPa

Pump stalled: ____Yes / ____No

Pump delivery rate at minimum pressure: _____L/min

Table E.3 – Hydraulic Power Test Data Sheet

	Flow Rate, L/min	Pressure, MPa	Power, 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 F
(informative)

Drawbar Power Test Data Sheet

Date of tests: _____

Type of track: _____

Table F.1 – Data Sheet for Drawbar Power Test

No.	Item	Height of drawbar above ground, mm	Tire Inflation, kPa	
			Front	Rear
F.1.1	Unballasted			
F.1.2	Ballasted			

Table F.2 – Noise Level Measurement

No.	Items	Trial 1	Trial 2	Trial 3
F.2.1	Noise level, dB (A)			
F.2.1.1	Operator			
F.2.1.1.1	With Load			
F.2.1.1.1	Without Load			

Table F.3 – Other Data to be taken for Drawbar Power Test

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
								°C	°C	°C	°C	%	kPa
F.3.1 Maximum Power in Tested Gears (unballasted tractor)													
F.3.2 Maximum Power in Tested Gears (ballasted tractor)													
F.3.3 Five-hour Tests													
F.3.3 .1 Five-hour Test at 75% of the pull corresponding to maximum power at rated speed													
F.3.3 .2 Five-hour Test at pull corresponding to 15% wheelslip (<i>trackslip</i> : ≥ 7%), with additional ballast : _____ kg													
					(*)	(*)							
F.3.4 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

Annex G
(informative)

Turning Circle and Turning Area Data Sheet

Table G.1 – Data Sheet for Turning Circle and Turning Area

	Right turn	Left turn
Radius of turning circle, mm		
Radius of turning area, mm		

Annex H (normative)

Formulas Used During Calculations and Testing

H.1 PTO torque

$$T = F \times L$$

where:

T	is the torque (N-m)
F	is the axle or rotary shaft load (kg)
L	is the length of brake arm (m)

H.2 PTO Power

$$P = \frac{2\pi TN}{60}$$

where:

P	is the PTO power (kW)
T	is the PTO torque (N-m)
N	is the speed of the shaft (rpm)

H. 3 Specific Fuel Consumption

$$SFC = \frac{F_c \times \rho_f}{P}$$

where:

SFC	is the specific fuel consumption (g/kW-hr)
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)

H.4 Drawbar Power

$$P_d = \frac{F \times S}{3.6}$$

where:

P_d	is the drawbar power (kW)
F	is the force measured (kN)
S	is the forward speed (km/hr)

H.5 Hydraulic Power

$$P_h = \frac{P_g \times Q}{1000}$$

where:

P_h is the hydraulic power (kW)
 P_g is the gage pressure (kPa)
 Q is the flow rate (lps)

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Bureau of Agriculture and Fisheries Standards
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Engineering Standard (PAES) for Four-Wheel Tractors- Methods of Test**

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