Foreword

This standard is a revision of the Standards Administrative Order (SAO) series of 1980 – "Standardization of Procedures of Inspection and Test for Walking-type Agricultural Tractor". The pursuance of this 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 was reviewed by the Technical Committee for Study 1- Development of Standards for Agricultural Production Machinery and was circulated to various private and government agencies/organizations concerned for their comments and reactions. This standard was presented to the Philippine Society of Agricultural Engineers (PSAE) and subjected to a public hearing organized by the National Agriculture and Fisheries Council (NAFC). The comments and reactions received during the presentation and public hearing were taken into consideration in the finalization of this standard.

This standard has been technically revised in accordance with PNS 01:Part 4:1998 - Rules for the Structure and Drafting of Philippine National Standards. The main changes are listed below:

- title of the standard has been modified in conformity to the format of International Standard;
- the scope was delineated thereby indicating the aspects covered and the limits of applicability; and
- items to be included in the test report were enumerated based on the actual test report submitted by AMTEC.

In the preparation of this standard, reference was made to the actual testing procedure for Walking-type Agricultural Tractor.

All annexes in this standard are normative.

Agricultural Machinery – Walking-Type Agricultural Tractor – Methods of Test

1 Scope

This standard specifies the methods of test and inspection for walking-type agricultural tractor, which can also be temporarily used for riding by the use of attachments. Specifically, it shall be used to:

1.1 verify the requirements specified in PAES 109 and PAES 110 and the specifications submitted by the manufacturer;

1.2 determine the field performance of the machine

1.3 evaluate the ease of handling and safety features

1.4 determine the laboratory performance of the machine

1.4.1 transmission efficiency

1.4.2 varying load performance

1.4.3 continuous running

1.5 prepare a report on the results of the tests

2 References

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

PAES 109:2000, Agricultural Machinery – Walking-Type Agricultural Tractor – Specifications – Part 1: Pull-type

PAES 110:2001, Agricultural Machinery – Walking-Type Agricultural Tractor – Specifications – Part 2: Rotary-tilling type

3 Definitions

For the purpose of this standard, the definitions given in PAES 109 and PAES 110 and the following shall apply:

3.1
applicable work
range of operations that could be performed by the machine as specified by the manufacturer

3.2
ground clearance
distance between the supporting surface and the lowest point of the tractor

3.3
overall height
distance between the horizontal supporting surface and the horizontal plane touching the uppermost part of the tractor

NOTE All parts of the tractor, in particular, fixed components projecting upwards are contained between these two planes.

3.4
overall length
distance between two vertical planes at right angles to the median plane of the tractor and touching its front and rear extremities

NOTE All parts of the tractor, in particular, components projecting at the front and at the rear are contained between these two planes. Where an adjustment of components is possible, it shall be set at minimum length.

3.5
overall width
distance between two vertical planes parallel to the median plane of the tractor, each plane touching the outer-most point of the tractor on its respective side and with wheels set for minimum track

NOTE All parts of the tractor, in particular, fixed components projecting laterally are contained between these two planes.

3.6
slip
ratio of the difference between the speed of pulley or belt and wheels or track with load, to the speed without load

3.6.1 Belt slip of pulley is determined by the following formula:

$$Belt\ slip, \% = \frac{n_0 - n_1}{n_0} \ x\ 100$$

where:

n_0 is the revolution/minute of the driven pulley without load, rpm
n_1 is the revolution/minute of the driven pulley with load, rpm

3.6.2 Slip of driving wheels or tracks is determined by the following formula:

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

where:

N_0 is the sum of the revolutions of all driving wheels for the same distance without load, rpm
N_1 is the sum of the revolutions of all driving wheels for a given distance with load, rpm

3.7
tractor weight
total weight of the machine excluding ballast and implements with the fuel tank filled to 80 percent capacity and with normal amount of cooling water and lubricating oil (if engine is integrated with the tractor) and with specified wheels.

3.8
walking-type agricultural tractor
self-propelled machine having a single axle designed primarily to pull and propel trailed or mounted agricultural implements and machinery

4 General Conditions for Test and Inspection

4.1 Role of the manufacturer/dealer

The manufacturer/dealer shall submit to the official testing agency the specifications and other relevant information on the walking-type agricultural 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.

4.2 Running-in and preliminary adjustment

Before the start of the test, the tractor should have undergone a breaking-in period. Before the field performance test, the tractor shall be operated at the test site to make the necessary adjustments as per manufacturer's recommendations. No adjustments shall be permitted during the test.

4.3 Test instruments and other needs

The suggested list of minimum field and laboratory test equipment and materials needed to carry out the tractor test is shown in Annex A. These instruments should be calibrated regularly. These instruments shall be physically checked for operation and shall be cleaned before and after each test. A checklist of instruments and materials shall be prepared to be used before departure to and from the testing area.

4.2 Suspension of test

If during the test run, the machine malfunctions so as to affect the machine's performance, the test may be suspended with the concurrence of the official testing agency and the manufacturer's representative. If it is the engine that fails, it 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. (see Annex A)

5.1.2 A plain and level platform shall be used for this investigation.

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

5.2 Field Performance Tests

5.2.1 These are carried out to test the field performance of operations applicable to the tractor to be tested. For wetland test field, the field shall be soaked for at least twenty-four (24) hours.

5.2.2 The tests shall be carried out on a dry/wet field where the soil type, dimensions, soil moisture content/depth of water, soil resistance, shape and other conditions are to be recorded.

5.2.3 The kinds of field performance tests shall be the following:

5.2.3.1 Plowing

This shall be done for fields of not less than 500 m^2 and shall be rectangular with sides in the ratio of 2:1 as far as possible with three replications using circuitous method of plowing operation. Plowing depth shall be 100 mm $\pm$ 10 mm. The field may be irrigated or flooded depending on the condition.

5.2.3.2 Rotary tilling

This shall be done for field of not less than 500 m^2 and shall be rectangular with the sides in the ratio of 2:1 as far as possible with three replications. Tilling depth shall be 100 mm to 120 mm. The field may be irrigated or flooded depending on the condition.

5.2.3.3 Harrowing

This shall be carried out after plowing test on the same field under dry/flooded conditions.

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

5.3 Laboratory Performance Tests

5.3.1 Transmission efficiency

5.3.1.1 This is carried out to determine the efficiency of the transmission system of the tractor, using an electric motor that is either calibrated or coupled with a torque transducer.

5.3.1.2 The tractor on test, without its wheels, shall be fixed on the test frame. Brake load is applied on the wheel axle and/or rotary tilling shaft by a dynamometer.

5.3.1.3 Power is transmitted from the motor output shaft to the input shaft (first shaft) of transmission box in the same manner as those from engine to that of tractor, for instance, V-belt. The diameter of the pulley on the output shaft of the electric motor is computed so that speed of input shaft at rated speed of electric motor is the same as that of rated engine speed. This test will not be applied to a tractor which engine and transmission box are directly coupled.

5.3.1.4 Brake load shall be applied until the computed axle power or tilling shaft power reaches the maximum value.

5.3.1.5 Items to be measured and recorded are given in Annex D.

5.3.2 Varying load performance

5.3.2.1 This is carried out to determine the performance of the tractor under different loadings applied to the wheel axle or rotary tilling shaft.

5.3.2.2 The tractor on test, with its engine but without its wheels, shall be fixed on the test frame.

5.3.2.3 The engine shall be set at its rated speed and brake load shall be applied on the wheel axle or rotary tilling shaft by a dynamometer at an increment of 5-kg load until the engine stalls.

5.3.2.4 The load, speed of engine output shaft, transmission input shaft and axle, fuel consumption and temperature of exhaust gas, transmission oil, atmospheric dry bulb and wet

bulb temperatures shall be measured simultaneously every 3 minutes at each applied brake load.

5.3.2.5 Items to be measured and recorded are given in Annex E.

5.3.3 Continuous-running test

5.3.3.1 This is carried out to evaluate the operating performance and to find out any abnormality or trouble under the continuous running condition of the tractor.

5.3.3.2 The tractor on test, with its engine but without its wheels, shall be fixed on the test frame. Brake load is applied on the wheel axle or rotary tilling shaft by a dynamometer.

5.3.3.3 The engine shall be set at its rated speed and a brake load equivalent to the maximum axle/rotary tilling shaft power taken during the varying load performance test shall be applied on the wheel axle/rotary tilling shaft.

5.3.3.4 The load, speed of engine, transmission input shaft and axle/rotary tilling shaft, fuel consumption, and temperature of exhaust gas and transmission oil shall be measured simultaneously every thirty (30) minutes.

5.3.3.5 The testing methods for each type of walking-type agricultural tractor shall be as follows:

5.3.3.5.1 Pull type

5.3.3.5.1.1 A brake load shall be applied on the wheel axle.

5.3.3.5.1.2 The change-gear position shall be at the largest-ratio-reduction within the plowing speed range mentioned in the specifications.

5.3.3.5.1.3 The duration of continuous running test shall be 5 hours.

5.3.3.5.2 Tilling type

5.3.3.5.2.1 A brake load shall be applied on the rotary tilling shaft.

5.3.3.5.2.2 The change-gear position shall be at the largest-ratio-reduction within the tilling speed range mentioned in the specifications.

5.3.3.5.2.3 The wheel axle shall be driven with no load.

5.3.3.5.2.4 The duration of continuous running test shall be five (5) hours.

5.3.3.5.3 Dual-purpose type

5.3.3.5.3.1 There shall be two kinds of tests under dual-purpose type: wheel axle loading and tilling shaft loading tests.

5.3.3.5.3.2 The method of loading on wheel axles and rotary tilling shaft shall be the same as in pull type and tilling type, respectively. However, the duration of continuous running shall be for two and a half (2.5) hours in either case.

5.3.3.6 Items to be measured and recorded are given in Annex F.

6 Data Analysis

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

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 hand tractor

7.7.1 Table 1 – Hand tractor Specifications

7.8 Results of Field Test

7.8.1 Table 2 – Field Performance Test Data

7.9 Results of Laboratory Tests

7.9.1 Table 3 – Results of Varying Load Performance Test

7.9.2 Table 4 – Results of Continuous Running Test

7.9.3 Table 5 – Results of Transmission Efficiency Test

7.10 Observations

7.11 Name and Signature of Test Engineers

Annex A

Suggested Minimum List of Field and Laboratory

Test Equipment and Materials

Items	Quantity
A1 Equipment	
A1.1 Field Equipment	
A1.1.1 Timers Range: 60 minutes: Accuracy 1/10	2
A1.1.2 Noise Level Meter Range : 30 to 130 db(A)	1
A1.1.3 Cone Penetrometer	1
A1.1.4 Steel Tape, 50 m	1
A1.1.5 Graduated Cylinder, capacity: 500 mL	1
A1.1.6 Width and Depth Gage	1
A1.1.7 Camera	1
A1.2 Laboratory Equipment	
A1.2.1 Load Cells, capacity:100 kg	2
A1.2.2 Strain Amplifier	1
A1.2.3 Multi-testers	2
A1.2.4 Tachometer, contact type	2
A1.2.5 Power Meter Maximum voltage and current: V_{rms} and 20 A_{rms}	1
A2 Materials for Field Test	
A2.1 Pegs	10
A2.2 Aluminum Foil	1
A2.3 Labeling Tags	10

Annex B

Inspection Sheet for Walking-type Agricultural Tractor

Name of Applicant : _____

Address : _____

Telephone No. : _____

Name of Distributor : _____

Address : _____

Name of Manufacturer : _____

Factory Address : _____

GENERAL INFORMATION

Brand :_____ Model :_____

Serial No. : _____Engine Serial No. : _____

Classification (pull type, tilling type or dual purpose type) : _____

Production date of walking-type agricultural tractor to be tested : _____

Items to be inspected

ITEMS	Manufacturer's Specification	Verification by Testing Agency
B1 Dimensions and weight of tractor		
B1.1 Overall length, mm		
B1.2 Overall width, mm		
B1.3 Overall height, mm		
B1.4 Ground clearance, mm		
B1.5 Weight of tractor (without engine), kg		
B2 Engine		
B2.1 Make/Country of Manufacture		
B2.2 Model		
B2.3 Serial Number		
B2.4 Type		
B2.4.1 Stroke		
B2.4.1.1 Four-stroke		
B2.4.1.2 Two-stroke		
B2.4.2 Ignition		
B2.4.2.1 Compression ignition		
B2.4.2.2 Spark ignition		

ITEMS	Manufacturer's Specification	Verification by Testing Agency
B2.5 Rated speed, rpm		

B2.6 Rated power, kW		
B2.7 Fuel system		
B2.7.1 Type of fuel		
B2.7.1.1 Gasoline		
B2.7.1.2 Diesel		
B2.7.2 Tank capacity, L		
B2.7.3 Fuel consumption, L/h		
B2.8 Cooling system		
B2.8.1 Air-cooled		
B2.8.2 Water-cooled		
B2.9 Starting system		
B2.9.1 Rope recoil		
B2.9.2 Hand cranked		
B2.10 Weight, kg		
B3 Type of clutch		
B3.1 Main clutch		
B3.2 Steering clutch (if any)		
B3.3 Tilling clutch (if any)		
B4 Power transmission system		
B4.1 Type		
B4.1.1 Chain and sprocket		
B4.1.2 Gears		
B4.2 Lubrication system		
B4.2.1 Splash type		
B4.2.2 Forced-feed		
B5 Engine pulley (outside diameter x no.of grooves x inside diameter, mm)		
B6 Input shaft pulley (outside diameter x no. of grooves x inside diameter, mm)		
B7 Axle, L x W, mm		
B8 Hexagonal hub		
B8.1 Thickness, mm		
B8.2 Length, mm		
B9 Type of hitch point		
B9.1 Type I – One-hole Hitch		
B9.2 Type II – Three-hole Hitch		
B10 Tractive Wheels		
B11.1 Pneumatic Tire Size		
B11.2 Cage Wheel Size, L x D, mm		
B11 Attachments		
B11.1 Plow		
B11.2 Harrow		
B11.3 Rotary tiller		

Annex C

Field Performance Test Data Sheet

Items to be Measured and Inspected

ITEMS	Trials			Average
	1	2	3	
C1 Test Conditions				
C1.1 Condition of field				
C1.1.1 Location				
C1.1.2 Soil type (clay, clay loam, sandy, etc)				
C1.1.3 Dimensions of field				
C1.1.3.1 Length, m				
C1.1.3.2 Width, m				
C1.1.3.3 Area, m^2				
C1.1.4 Depth of water/moisture content, mm/%				
C1.1.5 No. of hours soaked (wet land)				
C1.1.6 Soil resistance, kg/cm^2				
C1.1.7 Spacing of stubbles, mm (rows x hills)				
C1.1.8 Height of stubbles, mm				
C1.1.9 Weed growth, no/m^2				
C1.2 Weather conditions				
C1.2.1 Temperature				
C1.2.1.1 Wet bulb, ºC				
C1.2.1.2 Dry bulb, ºC				
C1.2.2 Weather (sunny, cloudy, rainy, hot, cold..)				
C1.3 Condition of the tractor				
C1.3.1 Tractive device				
C1.3.1.1 Type				
C1.3.1.2 Size				
C1.3.2 Implement to be used				
C1.3.2.1 Type				
C1.3.2.2 Size				
C1.3.3 Wheel track				
C1.3.4 Additional weight, kg				
C1.3.4.1 Front-end				
C1.3.4.2 Wheel				

ITEMS	Trials			Average
	1	2	3	
C1.3.5 Gross weight, kg				
C1.3.6 Speed-gear positions				
C1.3.6.1 Main transmission				
C1.3.6.2 Auxiliary transmission				
C1.3.6.3 Belt speed-change				
C1.3.6.4 Rotary speed change				
C1.3.7 Others				
C2 Field Performance				
C2.1 Date of test				
C2.2 Kind of field operation				
C2.3 Duration of test, min				
C2.4 Time lost				
C2.4.1 Turning, min				
C2.4.2 Others (specify), min				
C2.5 Type of implement				
C2.6 Method of operation				
C2.7 Depth of cut, mm				
C2.8 Travelling speed, kph				
C2.9 Theoretical width of tillage, mm				
C2.10 Actual width of tillage, mm				
C2.11 Theoretical field capacity, ha/h				
C2.12 Actual field capacity, ha/h				
C2.13 Field efficiency, %				
C2.14 Fuel consumed, L				
C2.15 Fuel consumption, L/h				
C2.16 Others (specify)				
C3 Observations:				
C3.1 Ease of handling and stability of the tractor				
C3.2 Ease of manipulating of the operating levers				
C3.3 Ease of replacing and adjusting the parts				
C3.4 Safety features				
C3.5 Failure or abnormalities that may be observed on the tractor or its component parts				
C3.6 Others				

Annex D

Transmission Efficiency Test Data Sheet

Test Specimen : _____
Prime Mover : _____
Test Engineer : _____
Test Conditions
1. Air Temperature
Dry Bulb, °C : _____
Wet Bulb, °C : _____
2. Relative Humidity, % : _____

Trial No. : _____
Date : _____
Place of Test : _____

	Motor	Input	Axle
No Load Speed, rpm :	_____	_____	_____
Speed Reduction Ratio:	_____		

Time	Axle Load, kg			Speed, rpm		Belt Slippage	Axle Torque	Axle Shaft Power	Input			Efficiency
	Left	Right	Total	Drive Shaft	Axle Shaft				Torque	Speed	Power	
min						%	kg-m	kW	kg-m	rpm	kW	%

Annex E

Varying Load Performance Test Data Sheet

E.1 Wheel Axle

Test Specimen : _____ Trial No. : _____
Prime Mover : _____ Date : _____
Test Engineer : _____ Place of Test : _____
Test Conditions
1. Air Temperature Motor Input Axle
Dry Bulb, °C : _____ No Load Speed, rpm : _____ _____ _____
Wet Bulb, °C : _____ Speed Reduction Ratio: _____
2. Relative Humidity, % : _____

Time	Axle Load, kg			Speed, rpm			Belt Slippage	Axle Torque	Axle Shaft Power	Temperature, °C		Fuel Consumption	Specific Fuel Consumption
	Left	Right	Total	Engine Shaft	Drive Shaft	Axle Shaft				Exhaust gas	Transmission oil		
min							%	kg-m	kW			L/h	g/kW-h

E.2 Rotary Tilling Shaft

Test Specimen : _____
Prime mover : _____
Test Engineer : _____

Trial No. : _____
Date : _____
Place of Test : _____

Test Conditions

1. Air Temperature
   Dry Bulb, °C : _____
   Wet Bulb, °C : _____
2. Relative Humidity, % : _____

Time	Rotary Shaft Load	Speed, rpm			Belt Slippage	Rotary Shaft Torque	Rotary Shaft Power	Temperature, °C		Fuel Consumption	Specific Fuel Consumption
		Engine Shaft	Drive Shaft	Rotary Shaft				Exhaust gas	Transmission oil		
min	kg				%	kg-m	kW			L/h	g/kW-h

Annex F

Continuous Running Test Data Sheet

F.1 Wheel Axle

Test Specimen : _____
Prime Mover : _____
Test Engineer : _____
Trial No. : _____
Date : _____
Place of Test : _____

Test Conditions

1. Air Temperature
   Dry Bulb, °C : _____
   Wet Bulb, °C : _____
2. Relative Humidity, % : _____

	Motor	Input	Axle
No Load Speed, rpm :	_____	_____	_____
Speed Reduction Ratio:	_____		

Time	Axle Load, kg			Speed, rpm			Belt Slippage	Axle Torque	Axle Shaft Power	Temperature, °C		Fuel Consumption	Specific Fuel Consumption
	Left	Right	Total	Engine Shaft	Drive Shaft	Axle Shaft				Exhaust gas	Transmission oil		
min							%	kg-m	kW			L/h	g/kW-h

F.2 Rotary Tilling Shaft

Test Specimen : _____
Prime Mover : _____
Test Engineer : _____
Trial No. : _____
Date : _____
Place of Test : _____

Test Conditions

1. Air Temperature
   Dry Bulb, °C : _____
   Wet Bulb, °C : _____
2. Relative Humidity, % : _____

Time	Rotary Shaft Load	Speed, rpm			Belt Slippage	Rotary Shaft Torque	Rotary Shaft Power	Temperature, °C		Fuel Consumption	Specific Fuel Consumption
		Engine Shaft	Drive Shaft	Rotary Shaft				Exhaust gas	Transmission oil		
min	kg				%	kg-m	kW			L/h	g/kW-h

Annex G

Formulas Used During Calculations and Testing

G1 Field Performance Test

G1.1 Estimation of Effective Field Capacity

G1.1.1 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

G1.1.2 Total distance traveled, *D*, (m)

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

where: $A = L \times W$

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

G1.1.3 Effective area accomplished, A_e, (m^2)

$$A_e = wD = 2nLw$$

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

G1.1.3.1 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

G1.1.3.2 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

G1.1.4 Effective field capacity, *efc*, (m^2/h)

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

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

G1.2 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

G1.3 Field Efficiency, F_{eff}, (%)

$$F_{eff} = \frac{efc}{tfc} \quad x \quad 100$$

G1.4 Fuel Consumption, *FC*, (L/h)

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

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

G2 Laboratory Tests

G2.1 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

G2.2 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

G2.3 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