PHILIPPINE NATIONAL STANDARD

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Agricultural machinery – Fans and Blowers – Methods of Test

BUREAU OF PRODUCT STANDARDS

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National Foreword

This Philippine Agricultural Engineering Standards PAES 241:2010, Agricultural machinery – Fans and Blowers – Methods of Test was approved for adoption as Philippine National Standard by the Bureau of Product Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD-DOST).

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) through the project "Development of Standards for Agricultural Production and Postharvest Machinery" funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development – Department of Science and Technology (PCARRD – DOST)

This standard has been technically prepared in accordance with BPS Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

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

Bleier, Frank P. 1998. *Fan handbook selection, application and design.* McGraw – Hill, Inc.

Energy performance assessment of fans and blowers.
http://www.energymanagertraining.com/GuideBooks/4Ch6.pdf <accessed May 14, 2009>

JIS B 8330:1981 – Testing methods for turbo-fans and blowers

CONTENTS

1 Scope

This standard specifies the methods of test and inspection for fans and blowers. Specifically, it shall be used to:

1.1 verify the mechanism, dimensions, materials, accessories of the fans and blowers and the list of specifications submitted by the manufacturer;

1.2 determine the performance of the machine;

1.3 evaluate the ease of handling and safety features; and

1.4 report 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 240:2008 Agricultural Machinery – Fans and Blowers – Specifications

3 Definitions

For the purpose of this standard, the definitions given in PAES 240 and the following shall apply:

3.1
air power
part of the energy per unit time that is imparted by the fan to the air by increasing its total pressure from the inlet to the outlet

3.2
angle of attack
angle measured between the air inlet and the lower camber of the fan/blower

3.3
back-flow
when the air flow/movement produces by fan/blower starts to reverse direction

3.4
fan
blower
device for moving air which utilizes a power driven rotating impeller

3.5
hub-tip ratio
ratio between the hub diameter and the fan/blower wheel diameter

3.6
lift-drag ratio
ratio between the lift force and the drag force on fan/blower blades during operation

3.7
pitot tube
tube that is being connected to a manometer and is being used to measure the static and total force of air in the testing duct of fan/blower (see Figure 3)

3.8
static air power
part of the energy per unit time that is imparted by the fan/blower to the air in overcoming static pressure from the inlet to the outlet

3.9
static pressure
potential energy put into the system by the fan/blower and is given up to friction in the ducts and at the duct inlet as it is converted to velocity pressure

3.10
throttling device
conical structure or orifice rings that are being used at the end of testing duct of fan/blower to enable variation in air volumetric flow rate (see Figure 1a and 1b)

3.11
total pressure
sum of the static and velocity pressure

3.10
traverse point
point in the duct at which measurement using pitot tube shall be done (see Figure 4)

3.11
velocity pressure
pressure along the line of the flow that result from the air flowing through the duct

4 General Conditions for Test and Inspection

4.1 Role of manufacturer/dealer

The manufacturer/dealer shall submit list of specifications and other relevant information about the fan/blower and shall abide with the terms and conditions set forth by an official testing agency.

4.2 Role of the operator

An officially designated operator shall be skilled and shall demonstrate, operate, adjust, and repair as the case maybe, related to the operation of the machine.

4.3 Test site conditions

The site should have ample provisions for material handling and workspace and electric connections and suitable for normal working condition.

4.4 Test instruments

The instrument to be used shall have been calibrated and checked by the testing agency prior to the measurements. The suggested list of minimum test instruments and materials needed to carry out the fan/blower test is shown in Annex A.

4.5 Termination of Test

If during testing, the machine stops due to major component breakdown or malfunctions, the test engineer from the official testing agency shall terminate the test.

5 Test and Inspection

5.1 Verification of the technical data and information of the manufacturer

5.1.1 This inspection is carried out to verify the mechanism, dimensions, materials and accessories of the fan/blower in comparison with the list of technical data and information of the manufacturer.

5.1.2 The items to be inspected and verified shall be recorded in Annex B.

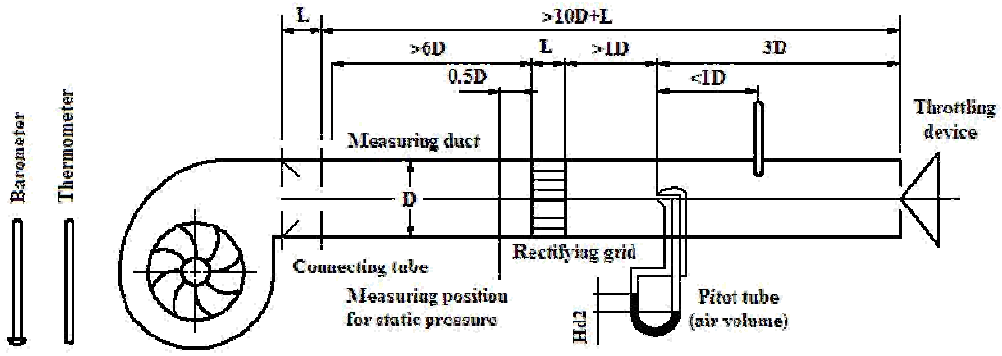
5.2 Performance test

5.2.1 This is carried out to obtain actual data on overall machine performance.

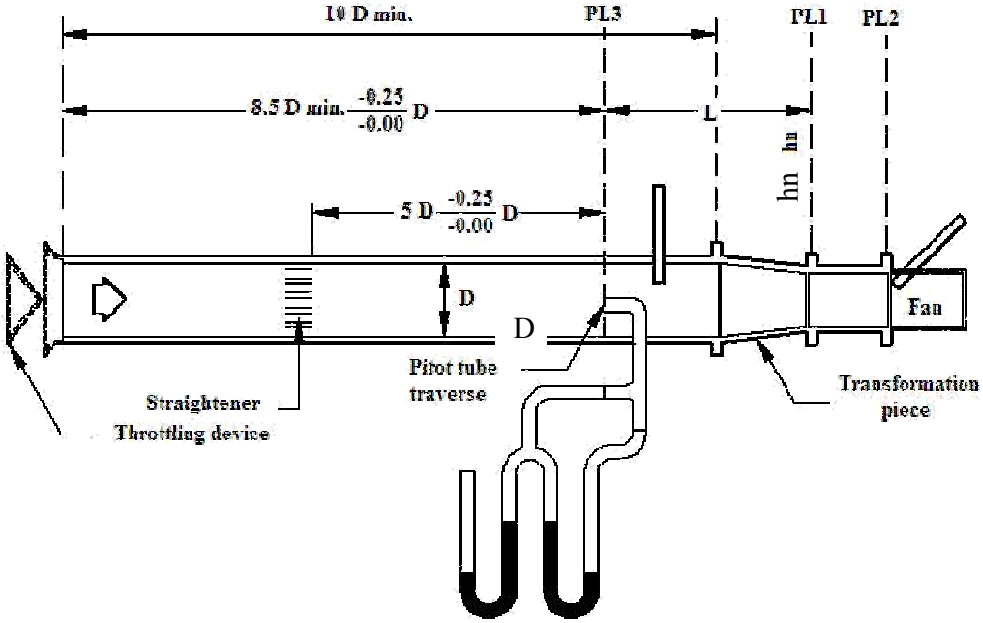
5.2.2 Visual inspection test shall be made on welded parts of the fan/blower and shall be recorded in Annex C.1.12

5.2.3 Air power and static air power determination test

5.2.3.1 The outlet (for blowers) or inlet (exhaust) duct shall be prepared for the testing of the variable outlet test. It shall have the area of plus or minus 5% of the fan/blower outlet area and shall have the length of 10 times its diameter. (see Figure 1)



A. Outlet duct set-up. (D – Diameter of test duct)



B. Inlet duct set-up. (D – Diameter of test duct)

Figure 1. Fan/Blower Test Duct

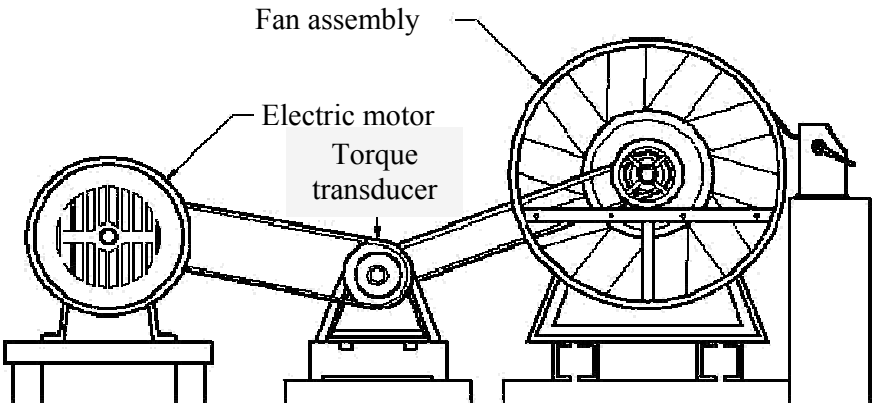


Figure 2. Front view of the testing set-up for fan/blower

5.2.3.2 Throttling device such as conical structure or orifice rings shall be provided to vary the air volume and static pressure of the test fan/blower.

5.2.3.3 Manometer or any suitable pressure measuring device (e.g. pressure transducer) shall be used on the testing duct to measure the static pressure and the total pressure. (see Figure 3)

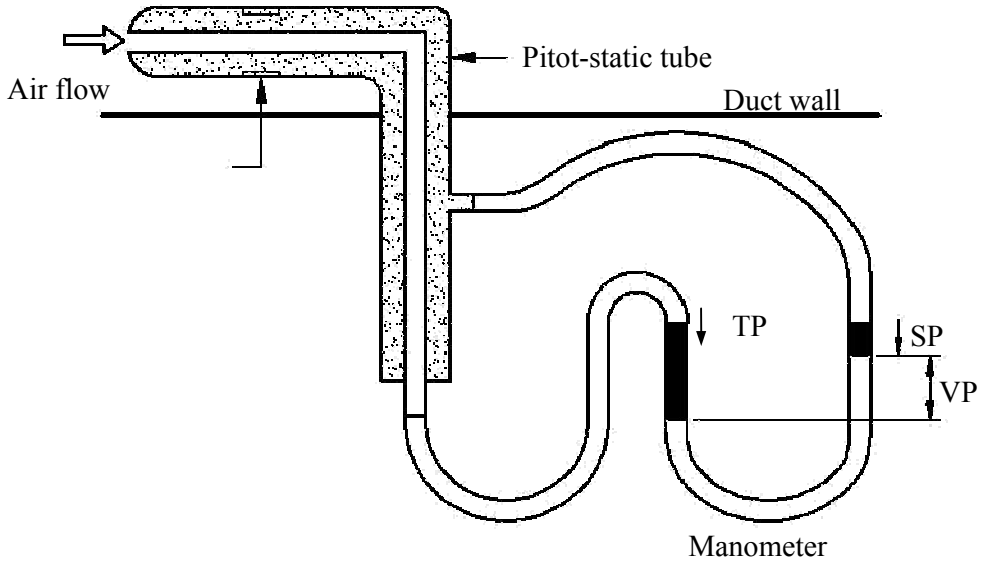


Figure 3. U-tube manometer connected to pitot tube

5.2.3.4 During the operation, the throttling device shall be used to vary the volume of air flow.

5.2.3.5 Static pressure at fully open condition and at condition in which the air produces by the fan/blower starts to back flow shall be measured using manometer. Manometer when measuring shall be aligned to the flow of air. The values obtained shall be the minimum and maximum static pressure, respectively.

5.2.3.6 The five (5) different conditions (1, 2, 3, 4 and 5) of the area of the duct opening shall be computed using the minimum and maximum static pressure. The formula used for computation shall be on Annex D.

5.2.3.7 At different volume of air flow, the following shall be gathered: power input in kW (if power meter is available), rotational speed of fan/blower shaft and prime mover in rpm, torque in kg-m, velocity of air in m/s, static pressure and total pressure in inch H_2O.

5.2.3.8 Velocity of air in m/s, static pressure and total pressure in inch H_2O at the 20 traverse/testing points of each testing duct condition mentioned shall be done. (see Figure 4)

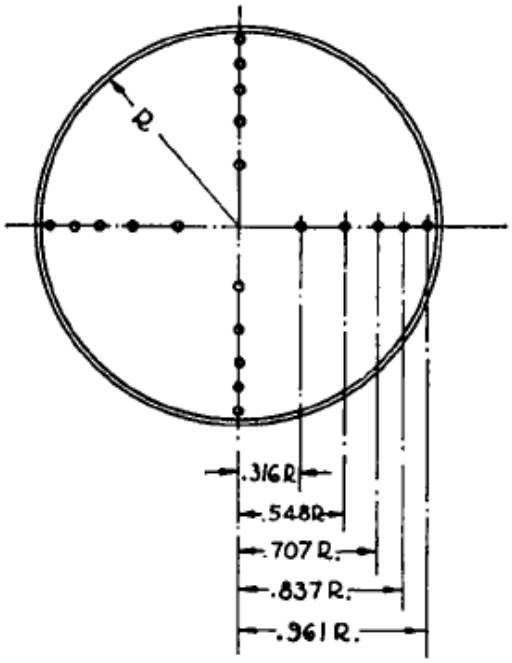


Figure 4. Traverse points across testing duct.

5.2.3.9 Data gathered shall be recorded on Annex C.

5.2.3.10 Computation of the power consumption, air power, static air power and overall fan/blower efficiency shall be done using the values recorded and the formula from Annex D.

5.2.3.11 Observations of any kind of failure on the fan/blower shall be recorded on Annex C.2.

5.2.4 Test trials

A minimum of three (3) test trials shall be adopted.

5.2.5 Data collection

Record sheet for all data and information during the test is given in Annex C.

6 Formula

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

7 Test Report

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

7.1 Title

7.2 Summary

7.3 Purpose and Scope of Test

7.4 Methods of Test

7.5 Description of the Machine

Table 1 – Machine Specifications

7.6 Results and Discussions

7.7 Observations (include pictures)

Table 2 – Performance test data

7.8 Names, signatures and designation of test engineers

.

Annex A

Suggested Minimum List of Test Instruments and Materials

A.1	Instruments	Quantity
A.1.1	Tachometer (contact type or photo electric type) Range: 0 rpm to 5,000 rpm	1
A.1.2	Pitot tube with U-tube manometer	1
A.1.3	Tape measure (with maximum length of 5m)	1
A.1.4	Noise level meter Range: 30 dB (A) to 130 dB (A)	1
A.1.5	Test Duct	1
A.1.6	Torque transducer	1
A.1.7	Vernier Caliper Accuracy: 0.1 mm	1
A.1.8	Scientific Calculator	1
A.1.9	Air Velocity Meter (handheld)	1
A.1.10	Power meter (for electric motor) 60Hz, 220V	1
A.1.11	Digital Camera	1
A.1.12	Handheld vibration meter Frequency range: (10Hz to 1 Hz)	1
A.1.13	Psychrometer	1

Annex B

Specifications of Fan/Blower

Name of Applicant/ Distributor: _____
Address: _____
Tel No: _____
Name of Manufacturer: _____
Address: _____
Tel No: _____

GENERAL INFORMATION

Make: _____ Type: _____
Serial No: _____ Brand/Model: _____
Production date of Fan/Blower: _____
Testing Agency: _____ Test Engineer: _____
Date of Test: _____ Location of Test: _____

Items to be inspected

ITEMS	Specification of the Manufacturer	Verification by the Testing Agency
B.1 Type of Fan/Blower		
B.2 Main Structure		
B.2.1 Material		
B.2.2 Overall dimensions, mm		
B.2.2.1 Length		
B.2.2.2 Width		
B.2.2.3 Height		
B.2.3 Weight, kg		
B.3 Fan/Blower Wheel/Blades		
B.3.1 Type of blade		
B.3.1 Material		
B.3.2 Angle of attack, degree		
B.3.3 Number of blade		
B.3.4 Dimensions, mm		
B.3.4.1 diameter of fan/blower wheel		
B.3.4.2 diameter of hub		
B.3.4.2 thickness of blade		
B.4 Driving Mechanism (for electric motor)		
B.4.1 Type		
B.4.2 Brand		
B.4.3 Make or manufacturer		
B.4.4 Serial number		
B.4.5 Rated power, kW		
B.4.6 Rated speed, rpm		

B.4.7 Frequency, Hz		
B.4.8 Voltage		
B.5 Driving Mechanism (for internal combustion engine)		
B.5.1 Brand		
B.5.2 Model		
B.5.3 Make or manufacturer		
B.5.4 Serial number		
B.5.5 Type		
B.5.6 Rated power, kW		
B.5.7 Rated speed, rpm		
B.5.8 Cooling system		
B.5.9 Starting system		
B.5.10 Weight, kg		

Annex C

Performance Test Data Sheet

Test Trial No. _____Date: _____
Test Engineer: _____Location: _____
Assistants: _____ Test Specimen: _____
Test Requested by: _____Manufacturer: _____

C.1 Results of the Performance Test	
C.1.1 Type of fan/blower	
C.1.2 Angle of attack, degree	
C.1.3 Lift-drag ratio	
C.1.4 Temperature (Ambient), °C	
C.1.4.1 Wet bulb temperature	
C.1.4.2 Dry bulb temperature	
C.1.5 Rotational speed, rpm	
C.1.5.1 Blower shaft	
C.1.5.1.1 Condition 1 (air starts to back-flow)	
C.1.5.1.2 Condition 2	
C.1.5.1.3 Condition 3	
C.1.5.1.4 Condition 4	
C.1.5.1.5 Condition 5 (fully open)	
C.1.5.2 Prime mover shaft	
C.1.5.2.1 Condition 1 (air starts to back-flow)	
C.1.5.2.2 Condition 2	
C.1.5.2.3 Condition 3	
C.1.5.2.4 Condition 4	
C.1.5.2.5 Condition 5 (fully open)	
C.1.6 Noise level, dB(A)	
C.1.6.1 Condition 1 (air starts to back-flow)	
C.1.6.2 Condition 2	
C.1.6.3 Condition 3	
C.1.6.4 Condition 4	
C.1.6.5 Condition 5 (fully open)	
C.1.7 Power consumption	
C.1.7.1 Power, kW	
C.1.7.1.1 Condition 1 (air starts to back-flow)	
C.1.7.1.2 Condition 2	
C.1.7.1.3 Condition 3	
C.1.7.1.4 Condition 4	
C.1.7.1.5 Condition 5 (fully open)	
C.1.8 Torque, kg.m	
C.1.8.1 Condition 1 (air starts to back-flow)	
C.1.8.2 Condition 2	
C.1.8.3 Condition 3	

C.1.8.4 Condition 4	
C.1.8.5 Condition 5 (fully open)	
C.1.9 Welding acceptance test (AWS D1.1:2000)	
C.1.9.1 Crack prohibition	
C.1.9.2 Weld/base-metal fusion	
C.1.9.3 Crater cross section	
C.1.9.4 Weld profile	
C.1.9.5 Time of inspection	
C.1.9.6 Undersize welds (if any)	
C.1.9.7 Undercut	
C.1.9.8 Porosity (presence of air holes on the welded part)	

C.1.10 Measurement taken on 20 traverse/test points

	Traverse points/Test points																				**Ave**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	
Air velocity, m/s																					
Condition 1 (air starts to back-flow)																					
Condition 2																					
Condition 3																					
Condition 4																					
Condition 5 (fully open)																					
Static pressure, inH_2O																					
Condition 1 (air starts to back-flow)																					
Condition 2																					
Condition 3																					
Condition 4																					
Condition 5 (fully open)																					
Total pressure, inH_2O																					
Condition 1 (air starts to back-flow)																					
Condition 2																					
Condition 3																					
Condition 4																					
Condition 5 (fully open)																					

C.2 Fan/blower performance

C.2.1 Electrical consumption, kW-h	
C.2.2 Volumetric flow rate, m^3/s	
C.2.3 Power input on fan/blower shaft, kW	
C.2.4 Fan/Blower mechanical efficiency, %	
C.2.5 Fan/Blower static efficiency, %	
C.2.6 Air power, kW	
C.2.7 Static air power, kW	
C.2.8 Overall efficiency, %	
C.2.9 Angle of attack, degrees	
C.2.10 Stoppage during operation*	
C.2.11 Unnecessary sound during operation*	
C.2.12 Fracture on the parts after operation*	
C.2.13 Presence of turbulence*	

*yes or no

C.3 Evaluate the following observations:

Items	**Remarks**
C.3.1 Ease of cleaning parts	
C.3.2 Ease of adjusting and repair of parts	
C.3.3 Ease of operation	
C.3.4 Safety	
C.3.5 Availability of the switches needed	
C.3.6 Ease of transporting the machine	

C.4 Other Observations:

_____
_____
_____
_____

Annex D

Formula

D.1 Different Testing Duct Area Conditions

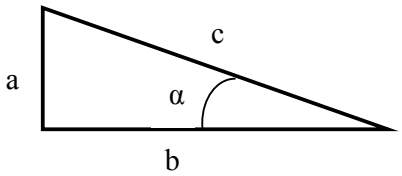
$$V = \frac{(MAX_{SP} - MIN_{SP})}{4}$$

Condition 1 = MAX_{SP} (air from fan/blower starts to back-flow)
Condition 2 = MAX_{SP} – V
Condition 3 = Condition 2 – V
Condition 4 = Condition 3 – V
Condition 5 = MIN_{SP} (fully open)

where:

MAX_{SP} = maximum static pressure, in H_2O
MIN_{SP} = minimum static pressure, in H_2O
V = variable to get the conditions 2, 3 and 4

D.2 Angle of attack



$$\alpha = \cos^{-1}(b/c)$$

where:

α = angle of attack, degree
c = total chord length of the fan/blower blade

D.3 Volumetric Flow rate

$$Q = A_{duct} \times V_{air}$$

$$V_{air} = \sqrt{2g\frac{h_d}{\gamma}}$$

$$\hbar_d = \frac{1}{m} \times (h_1 + h_2 + h_3 + \ldots\ldots + h_m)$$

where:

Q	=	volumetric flow rate, m^3/s
A_{duct}	=	cross-sectional area of duct, m^2
V_{air}	=	average velocity of air, m/s
g	=	acceleration due to gravity (9.8 m/s^2)
Y	=	unit volumetric weight of air in test duct, kg/m^3
$\hbar_d$	=	mean dynamic pressure, mm H_2O
h	=	dynamic pressure, mm H_2O

D.4a Power Input (for Electric Motor))

$$Pi = E \times I \times \cos \theta$$

where:

Pi	=	power input, kW
E	=	voltage, V
I	=	current, A
cos ɵ	=	power factor

D.4b Power Input (for Internal Combustion Engine)

$$Pi = F_c \times HHV_f \times \rho_f$$

where:

Pi	=	power input, kW (1 kCal/s = 4.184 kW)
Fc	=	biomass fuel consumption, L/s
HHV_f	=	high heating value of fuel used, kCal/g (see Table 1)
ρ_f	=	density of fuel used, g/L (see Table 2)

D.5 Air Power

$$P_a = \frac{Q \times \Delta pt}{6120}$$

where:

P_a	=	air power, kW
Q	=	air flow rate, m^3/min
Δpt	=	total pressure, mm H20

D.6 Static Air Power

$$P_{as} = \frac{Q \times \Delta ps}{6120}$$

where:

P_{as} = static air power, kW
Q = air flow rate, m^3/min

Δps = static pressure, mm H_20

D.7 Overall Efficiency

$$Eff_o = \frac{P_a}{P_i} \times 100$$

where:

Eff_o = overall efficiency, %
P_a = air power, kW
P_i = power input, kW

Table 1. List of high heating value of fuel

Fuel Type	High Heating Value, BTU/lb	High Heating Value, kCal/g
Gasoline	20,750	11.504
Diesel Fuel	19,200	10.644

Table 2. List of fuel density

Fuel Type	Density, g/L
Gasoline	726
Diesel Fuel	782

Philippine Agricultural Engineering Standards

AMTEC-UPLB – PCARRD Project: "Development of Standards for Agricultural Production and Postharvest Machinery"

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DEPARTMENT OF TRADE & INDUSTRY PHILIPPINES

BUREAU OF PRODUCT STANDARDS

3F Trade and Industry Building
361 Sen. Gil J. Puyat Avenue, Makati City 1200, Metro Manila, Philippines
T/ (632) 751.3125 / 751.3123 / 751.4735
F/ (632) 751.4706 / 751.4731
E-mail : bps@dti.gov.ph
www.dti.gov.ph