

PHILIPPINE NATIONAL STANDARD

PNS/BAFS/PAES 215:2017

Agricultural Machinery – Coffee Roaster – Methods of Test



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Foreword

The implementation of Republic Act 10601 also known as the Agricultural and Fisheries Mechanization (AFMech) Law of 2013 mandated the Bureau of Agriculture and Fisheries Standards (BAFS) to develop standard specifications and test procedures for agricultural and fisheries machinery and equipment.

The Bureau, in collaboration with the Bureau of Agricultural and Fisheries Engineering (BAFE), concerned Department of Agriculture (DA) Bureaus, and attached agencies, Professional Regulatory Board of Agricultural and Biosystems Engineering (PRB-ABE), and University of the Philippines Los Baños – Agricultural Machinery Testing and Evaluation Center (UPLB-AMTEC), embarked on a project entitled “**Development of Philippine National Standard/ Philippine Agricultural Engineering Standard for Various Agricultural Machinery**”. This project covers the development of PNS for Coffee Roaster.

In the Philippines, coffee is considered as one of the most highly demanded crops. Arabica, Robusta, Excelsa and Liberica are four of the coffee varieties that can be grown in the country because of its climatic and soil condition. Currently, the country is involved in trading various coffee products such as green coffee bean (GCB), ground coffee, unground coffee, roasted coffee and coffee extracts. All these products except GCB underwent roasting process.

Roasting of coffee beans has an effect on its taste and aroma. The development of specifications and test procedures for coffee roaster is therefore essential to ensure the quality of roasted coffee beans by establishing minimum requirements of the roaster.

This standard will serve as reference for Agricultural and Biosystems Engineers (ABEs) in the preparation and evaluation of specifications and test reports for coffee roasters pursuant to Republic Act No. 10915 otherwise known as the Philippine Agricultural and Biosystems Engineering Act of 2016.

This standard has been technically prepared in accordance with Bureau of Philippine Standards (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.

1 Scope

This standard specifies the methods of test for coffee roasters. Specifically, it shall be used to:

- 1.1 verify the mechanisms, dimensions, materials and accessories of the coffee roaster 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:

PNS/PAES/BAFS 214:2017 Agricultural Machinery – Coffee Roaster – Specifications

PAES 103:2000 Agricultural Machinery – Method of Sampling

3 Definitions

For the purpose of this standard, the definitions given in PNS/PAES/BAFS 214:2017 Agricultural Machinery – Coffee Roaster – Specifications and the following shall apply:

3.1

non uniformly roasted beans

coffee beans which show a lighter or darker color compared to the whole batch

3.2

moisture content (wet basis)

amount of moisture in the coffee beans expressed as percent of the total weight of the sample

3.3

overall height

distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the roasting machine

3.4

overall length

distance between the vertical planes at the right angles to the median plane of the roaster and touching its front and rear extremities

3.5

overall width

distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the roaster on its respective side

3.6

profile

monitoring of the temperature of the coffee during the roasting process; usually in the form of a graph of temperature against time

3.7

prime mover

used to run the coffee roaster

3.8

specific energy consumption

ratio of the electric, diesel, or liquefied petroleum gas (LPG) consumption and the amount of coffee beans processed, expressed in kilowatt-hour per kilogram or kilojoule per kilogram

3.9

test applicant

manufacturer, direct importer, or any legitimate distributor, dealer, or end-user of the machine

4 General Conditions for Test

4.1 Selection of coffee roaster to be tested

Coffee roaster submitted for testing shall be sampled in accordance to PAES 103:2000 Agricultural Machinery – Method of Sampling.

4.2 Role of the test applicant

The test applicant shall submit specifications and other relevant information about the coffee roaster. They shall abide with the terms and conditions set forth by the official testing agency, provide testing materials and shoulder other variable cost.

4.3 Role of the 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 Test site conditions

The coffee roaster shall be tested as installed for normal operation. The site should have ample provisions for material handling, temporary storage, workspace and suitable for normal working condition. Adequate ventilation and lighting shall be provided in the area.

4.5 Suspension/Termination of test

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

5 Test Preparation

5.1 Preparation of the coffee roaster for testing

The representative of the test applicant and testing agency shall check the coffee roaster so as to ensure that the roaster has been assembled and installed in accordance with the instruction of the manufacturer. The official testing agency will test the coffee roaster according to the desired output of the manufacturer. If the temperature gauge of the coffee roaster is not built in, it shall be calibrated.

5.2 Test instruments and other materials

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

5.3 Test materials

Dried GCB to be used shall be from commonly or locally grown coffee variety with 9-12% moisture content (wet basis). The amount of test material to be supplied shall be sufficient for the required test trials and laboratory tests. At least three (3) trials shall be conducted. However, if the test materials are not conforming to the recommended quantity and characteristics, the test engineer shall not pursue the test.

6 Pre-Test Observation

6.1 Verification of specifications

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

6.2 Test samples

Random representative test samples shall be collected from the test material for determination of moisture content. Samples shall be prepared in such a way that test sample to be used for the running-in and in each test trial have identical characteristics in terms of moisture content and variety. Care should be taken so as to prevent alterations of the conditions of the test samples. Sampling procedure is shown in Annex C.

7 Performance Test

7.1 Operation of the coffee roaster

The coffee roaster shall be operated for sufficient duration with load at the test site by the official representative of the test applicant using the manufacturer's recommended setting. The same setting recommended by the manufacturer shall be maintained during the test run. The testing agency shall make all measurements, which form part of the test and take the prescribed samples. After the test run, the coffee roaster shall be cleaned, cooled to the initial temperature of the machine before starting the test trial, and then prepared for the next test trial. This procedure shall be repeated for the succeeding test trials.

7.2 Test trials

There shall be a minimum of three (3) test trials with duration depending on the degree of roast of the output. The coffee roaster shall be tested for dark roast or depending on the requested degree of roast of the test applicant.

7.3 Sampling

Samples shall be collected at the output outlet of the cooling tray during each test trial. Sampling procedure is shown in Annex C.

7.4 Data collection

7.4.1. Duration of test

The duration of each test trial shall start from the time the heat is introduced to the chamber with GCB and ends depending on the preferred degree of roast.

7.4.2 Noise level

The noise emitted by the machine, with or without load, shall be measured using a noise level meter at the location of the operator(s). The noise, expressed in decibel [dB (A)], shall be measured approximately 50 mm away from the ear level of the operator(s).

7.4.3 Power requirement/fuel consumption

The procedure for determining power requirement or fuel consumption is given in Annex C.

7.4.4 Speed of components

The speed of the rotating shafts of the major components of the coffee roaster and the speed of the cylinder for drum roaster during roasting operation shall be taken using a tachometer.

NOTE Measurements shall be taken with and without load.

7.5 Data Recording and Observations

Record sheet for all data and information during the test is given in Annex D. Observations to be taken during the performance test shall be recorded in this sheet.

8 Laboratory Analysis

Laboratory analysis shall be made to determine the moisture content and percent broken RCB. The laboratory procedure to be followed in the analysis is given in Annex E while the data sheet is given in Annex F.

9 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 and D. Observations made on the machine while in operation shall be supported with photographs.

10 Formula

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

11 Test Report

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

11.1 Title

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

11.3 Purpose and Scope of Test

11.4 Methods of Test

11.5 Conditions of the Machine

11.6 Description of the Machine

11.7 Results and Discussions

11.8 Observations (include pictures)

11.9 Names and Signatures of Test Engineers

12 Bibliography

Coffee Search. (2015). Coffee Roaster.

IS 3077:1992 Indian Standard Roasted and Ground Coffee – Specifications
Philippine Coffee Board, Inc. (2002). From Bean to Brew. Retrieved from
<http://philcoffeeboard.com/from-bean-to-brew/>

Roast Magazine. *Roaster's Dictionary*. Retrieved from
<http://roastmagazine.com/education/RoastersDictionary.pdf>

Specialty Coffee Association of America, Roast Color Classification system (2010).

**Annex A
(normative)**

**Minimum List of Field and Laboratory
Test Equipment and Materials**

A.1 Field Test Equipment and Materials

EQUIPMENT/MATERIAL	QUANTITY
A.1.1 Hand-held Tachometer	1
A.1.2 Stop Watch Resolution: 0.1 second	2
A.1.3 Measuring Tape	1
A.1.4 Noise Level Meter Range: 30 – 130 dB (A)	1
A.1.5 Weighing Scale Capacity: 100 kg Resolution: 0.1 kg	1
A.1.6 Clamp-on AC/DC Power Meter 1000 V	1
A.1.7 Camera	1
A.1.8 Non-contact thermometer	1

A.2 Laboratory Test Equipment and Materials

EQUIPMENT/MATERIAL	QUANTITY
A.2.1 Digital Weighing Scale Resolution: 0.01 g Capacity: 2500 g	1
A.2.2 Moisture Meter	1
A.2.3 Labeling Tags which include: Date of Test Coffee Roaster on Test Sample Source Variety Trial Number	20

**Annex B
(informative)**

Specifications of Coffee Roaster

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

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

General Information:
 Serial No. : _____ Brand/Model : _____
 Classification : _____ Make : _____
 Production date of the machine to be tested: _____

Item*	Manufacturer's Specification	Verification by the Testing Agency
B.1 Main structure		
B.1.1 Overall dimensions (mm)		
B.1.1.1 Length		
B.1.1.2 Width		
B.1.1.3 Height		
B.1.2 Weight (kg), if applicable without the prime mover		
B.2 Rated roasting capacity (kg/h)		
B.3 Heat Source		
B.4 Input Chute		
B.4.1 Overall dimensions (mm)		
B.4.1.1 Length		
B.4.1.2 Width		
B.4.1.3 Height		
B.4.2 Height from the ground (mm)		
B.4.3 Material		
B.4.4 Location		
B.4.5 Means of attachment		
B.5 Output Chute		
B.5.1 Overall dimensions (mm)		
B.5.1.1 Length		
B.5.1.2 Width		
B.5.1.3 Height		
B.5.2 Height from the ground (mm)		
B.5.3 Material		
B.5.4 Location		

B.5.5 Means of attachment		
B.6 Roasting Mechanism		
B.6.1 Type		
B.6.2 Dimension, D x H x T (mm)		
B.6.3 Material		
B.7 Cooling Tray		
B.7.1 Dimension, D x H x T (mm)		
B.7.2 Material		
B.7.3 Capacity		
B.8 Safety devices		
B.9 Special features		

*The parameter will be checked upon availability.

B.9 Illustration of transmission system

Annex C (normative)

Sampling Procedures and Measurements

C.1 Sampling Procedures for GCB Input

The conditions of the GCB input such as moisture content to be used in each test shall be taken using three (3) “representative samples”, which represent the different conditions of GCB input in the bulk. This is done by randomly taking samples at the top, middle and bottom portions of the bulk. Half of the sample shall be used for laboratory analysis and the other half shall be used for reference purposes or for an eventual second check in case of review. Samples representing the materials for each test trial shall be placed in appropriate containers for laboratory analysis.

C.2 Sampling from the output chute of cooling tray

During each test trial, three (3) samples, each weighing at least 500 g shall be collected. The minimum amount of sample to be taken from the outlet of the coffee roaster to be analyzed in the laboratory for the determination of moisture content, purity and degree of roast shall be twice as much as what is needed for a particular analysis.

C.3 Handling of Samples

All samples to be used must be properly labeled and kept in airtight, dry and food grade containers.

C.4 Other Measurements Required During the Test Run

The speed of rotating components and noise level at operator’s location shall be taken. For each data, there shall be a minimum of five (5) observations. Before taking the data, it should be ensured that the feed rate, speed and other functional characteristics have stabilized.

C.5 Measurement of Power Requirement (electric motor)

Use a power meter to measure the voltage, current, and the total electric power requirement of the coffee roaster. There shall be three (3) sets of data with a minimum of five (5) observations per set taken with and without load.

C.6 Measurement of Energy Requirement (heat source)

C.6.1 Using LPG

The initial weight of the LPG tank, its weight after the test trial and the duration of the operation shall be recorded. This shall be done in all test trials.

C.6.2 Using diesel

To get the amount of diesel consumed, the tank shall be filled to full capacity before the test. After the test, fill the tank with measured diesel to the same level before the test. When filling up the tank, careful attention shall be paid to keep the tank horizontal and not to leave empty space in the tank.

**Annex D
(informative)**

Performance Test Data Sheet

Test Trial No.: _____ Date: _____
 Test Engineers: _____ Location: _____
 Assistants: _____ Machine: _____
 Test Requested By: _____ Manufacturer: _____

Items	Trial 1	Trial 2	Trial 3	Average
D.1 Green Coffee Beans				
D.1.1 Source				
D.1.2 Variety				
D.1.3 Moisture content (%)				
D.1.4 Average Particle Size				
D.2 Weight of input (kg)				
D.3 Weight of output (kg)				
D.4 Operating time (h)				
D.5 Roasting capacity (kg/h)				
D.6 Roasting efficiency (%)				
D.7 Specific energy consumption				
D.8 Speed of prime mover (rpm)				
D.8.1.1 Without load				
D.8.1.2 With load				
D.9 Noise level [dB (A)]				
D.9.1 Without load				
D.9.2 With load				
D.10 Power requirement				
D.10.1 Power (kW)				
D.10.1.1 Without load				
D.10.1.2 With load				
D.10.2 Current (A)				
D.10.2.1 Without load				
D.10.2.2 With load				
D.10.3 Voltage (V)				
D.10.3.1 Without load				
D.10.3.2 With load				
D.11 Fuel Consumption (kg/h)				

D.13 Other Observations

D.13.1 Ease of transporting the machine

D.13.2 Ease of cleaning the machine

D.13.3 Ease of adjusting and repairing of parts

D.13.4 Ease of loading input and collecting output

D.13.5 Safety

D.13.6 Labor Requirements

D.13.7 Failure or abnormalities that may be observed on the machine or its component parts during and after the cleaning operation.

D.13.8 Others

Annex E
(normative)

Laboratory Analysis

E.1 Determination of Moisture Reduction Rate

Determine the moisture content of the GCB and RCB, then record it as the initial and final moisture content, respectively. Compute for the moisture reduction rate.

E.2 Determination of Percent Broken RCB

Take three (3) 100-g sample each of the GCB from the input and RCB from the cooling tray. Manually separate the broken GCB and RCB and label them as initially broken and broken after operation, respectively. Weigh and record it to compute for the percent broken RCB.

**Annex F
(informative)**

Laboratory Analysis Data Sheet

Machine Tested: _____ Analyzed By: _____

Date of Test: _____ Date Analyzed: _____

F.1. Moisture Reduction Rate

	Trial 1	Trial 2	Trial 3	Average
Moisture content, wet basis of GCB (%)				
Moisture content, wet basis of RCB (%)				
Moisture Reduction Rate (kg/h)				

F.2 Percent Broken RCB Determination

ITEMS		Trial 1				Trial 2				Trial 3				General Average
		a	b	c	Ave	a	B	c	Ave	a	b	c	Ave	
GCB	Sample wt. (g)													
	Wt. of broken (g)													
RCB	Sample wt. (g)													
	Wt. of broken (g)													

Annex G (normative)

Formula Used During Calculations and Testing

G.1 Moisture Content Reduction Rate

$$M_{rr} = \frac{MC_g - MC_r}{T}$$

where:

M_{rr}	is the moisture reduction rate (%/h)
MC_g	is the moisture content of GCB input (%)
MC_r	is the moisture content of RCB output (%)
T	is the total roasting time (h)

G.2 Roasting Capacity

$$C_r = \frac{W_r}{T_o}$$

where:

C_r	is the roasting capacity (kg/h)
W_r	is the total weight of RCB (kg)
T_o	is the total operating time (h)

G.3 Percent Broken RCB

$$B_b = \frac{W_{ba} - W_{bg}}{N} \times 100$$

where:

B_b	is the mechanically damaged bean (%)
W_{bg}	is the weight of broken GCB initially(g)
W_{ba}	is the weight of broken RCB after operation(g)
N	is the 100 gram sample

G.4 Roasting Recovery

$$R_r = \frac{W_f}{W_i} \times 100$$

where:

- R_r is the roasting recovery (%)
- W_i is the initial weight of the GCB (g)
- W_f is the final weight of the RCB (g)

G.5 Fuel Consumption

$$F_c = \frac{W_i - W_f}{T}$$

where:

- F_c is the fuel consumption (kg/h)
- W_i is the initial weight of LPG tank (kg)
- W_f is the final weight of LPG tank (kg)
- T is the total roasting time (h)

G.6 Specific energy consumption

G.6.1 Using electricity as heat source

$$SEC = \frac{E_c \times T}{W_g}$$

where:

- SEC is the specific energy consumption (kW-h/kg)
- E_c is the electric power consumed (kW)
- T is the total roasting time (h)
- W_g is the initial weight of the GCB (kg)

G.6.2 Using LPG or diesel as heat source

$$SEC = \frac{F \times HV}{W_g}$$

where:

- SEC is the specific energy consumption (kJ/kg)
- F is the fuel consumed (kg)
- HV is the heating value of the LPG or diesel (h)
- W_g is the initial weight of the GCB (kg)

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