Foreword

The revision of this standard PAES 201:2000, Agricultural Machinery: Heated-Air Mechanical Grain Dryer – Specifications was initiated by Agricultural Machinery Testing and Evaluation Center (AMTEC) through the project "Standardization of Postharvest Machinery Testing and Evaluation" funded by the Bureau of Postharvest Research and Extension (BPRE) of the Department of Agriculture (DA).

This revised standard was reviewed by the Study Team for the Formulation of Standards for Grain Dryer and by the Technical Committee on Postharvest 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).

This second revision has been technically revised in accordance with PNS 01: Part 4:1998 – Rules for the Structure and Drafting of Philippine National Standards.

The comments and reactions received during the presentation and public hearing were taken into consideration in the finalization of this standard. The following were the modifications to this standard:

- criteria for performance;
- requirements for safety was included;
- uniformity of parts and components under Workmanship and Finish was considered;
- warranty period provided to parts and services were specified;
- basic tools, operation and parts manual were required.

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

ISO/DIS 11520-1 Agricultural Grain Dryers – Determination of Drying Performance

Part 16 and 17 of the Regional Network for Agricultural Machinery Test Codes and Procedures for Continuous Flow and Batch Rice Dryers

Status of Grain Dryers in the Philippines by Justin Tumambing, paper presented at the workshop of Standardization for grain dryers. NAPHIRE, Nueva Ecija.

Agricultural Machinery – Heated-Air Mechanical Grain Dryer – Specifications

1 Scope

This standard specifies the requirements for heated–air mechanical grain dryer used for commercial purposes. It does not include dryers for seeds.

The grain in this standard refers to palay and corn.

2 Reference

The following document contains provisions, which, through reference in this text, constitute provisions of this Standard:

PAES 202:2000 – Agricultural Machinery: Heated–Air Mechanical Grain Dryer – Methods of Test.

3 Definitions

For the purpose of this standard, the following definitions shall apply:

3.1
batch type
mechanical grain dryer wherein the grain in fixed volume is held in the drying chamber in batches until the grain reaches the desired moisture content

3.1.1
flat bed type
shallow bed batch type dryer wherein a fixed volume of grain is held stationary in a horizontal grain holding bin

3.1.2
recirculating type
batch type dryer equipped to circulate and/or mixed fixed volume of grain during the drying operation

3.1.3
vertical bin type
columnar type
batch type dryer wherein a fixed volume of grain is held stationary in a vertical grain holding bin

3.2

continuous flow dryer
dryer in which the material being dried moves through the drying chamber in a substantially continuous stream and is discharged without being recirculated

3.2.1
concurrent flow type
parallel flow type
continuous flow dryer wherein the product being dried moves in the same direction as drying air

3.2.2
counter-flow type
continuous flow dryer wherein the grain being dried move in one direction and the drying air moves in the opposite direction

3.2.3
cross-flow type
continuous flow dryer wherein the flow of air is transverse to the direction of flow of the grain being dried

3.2.4
mixing type
continuous flow dryer wherein the drying bin is similar to columnar drying bin except that it includes louvers causing mixing to occur as the grain flows through the system

3.2.5
non-mixing type
continuous flow dryer wherein the grains in the drying bin flows through the column in a straight path

NOTE. It consists of two parallel screens or columns of louvers. The space between the two columns is the plenum chamber where heated air is introduced and forced through the grain.

3.3
cracked grain
grains which show signs of fissures or fractures or splinters

3.4
dryer, direct-fired
dryer in which the products of combustion come into direct contact with the product being dried

3.5
dryer, indirect-fired
dryer in which the products of combustion do not come in contact with the products being dried

3.6
drying efficiency
heat utilization efficiency
ratio of the total heat utilized to vaporize moisture in the material, to the amount of heat added to the drying air expressed in percent

3.7
dust collecting system
device used to collect dust (i.e. consist of aspiration fan, cyclone, etc.)

3.8
fan
blower
air moving device that is used to force heated air through the mass of grains at the desired air flow rate and pressure

3.9
grain dryer
device for removing excess moisture from the grain, generally by forced or natural convection with or without addition of heat

3.10
head rice
grain or a fraction of grain with its length equal to or greater than eight-tenth (8/10) of the average length of the whole grain

3.11
heated-air mechanical grain dryer
device used to remove grain moisture by forcing heated air through the grain mass until the desired moisture content is attained

3.12
heating system efficiency
product of combustion efficiency and burner/furnace efficiency

3.13
moisture gradient
difference between the maximum and the minimum grain moisture content randomly sampled after drying

3.14
multi-pass dryer
mechanical grain dryer wherein grain is passed intermittently in cycles or stages through a drying chamber either by mechanical means or by gravity with subsequent cooling and tempering until the grain reaches the desired moisture content

3.15

plenum
chamber wherein air pressure is developed for uniform distribution of the heated air through the grain mass

3.16
safety device
any device that is used to avoid human accident and/or damage to the parts and components of the dryer during the operation and automatically shuts-off the operation of the dryer in case of malfunction

4 Classification

Heated-air mechanical grain dryers shall be classified as follows:

4.1 System of Operation

4.1.1 Batch type

4.1.1.1 Flat Bed

4.1.1.2 Recirculating

4.1.1.3 Vertical Bin

4.1.2 Continuous Flow

4.1.2.1 Concurrent-flow

4.1.2.2 Counter-flow

4.1.2.3 Cross-flow

4.1.2.4 Mixing

4.1.2.5 Non-mixing

4.2 Heating System

4.2.1 Method of Heat Introduction

4.2.1.1 Direct

4.2.1.2 Indirect

4.2.2 Fuel Source

4.2.2.1 Conventional

4.2.2.2 Non-conventional

5 Requirements

5.1 Performance

5.1.1 The performance of heated-air mechanical grain dryers shall be as specified in Table 1.

Table 1 – Performance Criteria for Mechanical Grain Dryer

CRITERIA	RICE	CORN
	Batch/ (Continuous Flow)	**Batch/ (Continuous Flow)**
1. Final moisture content, % w.b.	14	14
2. Moisture gradient, %, max.	2.0	2.0
3. Product quality*		
- Cracked grain, % increase, max.	5.0 (2.0)	35.0
- Head rice, % decrease, max.	5.0	N/A
- Hulled/damaged grain, % increase, max.	3.0	N/A
- Brokens/Split kernels, % increase, max.	N/A	7.0
4. Spillage, %, max.	0.5	0.5
5. Drying efficiency, % min.	75	75
6. Heating system efficiency, % min		
- Petroleum based fuel direct-fired	90	90
indirect-fired	75	75
- Biomass fuel direct-fired	65	65
indirect-fired	50	50

* allowable difference between the laboratory analysis and machine's performance

5.1.2 The indicated grain holding capacity must be attained.

5.1.3 The dried grain shall have no additional discoloration, no traces of unburned fuel or ashes on grain surface and no fermented or musty smell.

5.1.4 The dryer shall be provided with thermometer to measure the actual air temperature entering the grain mass and a pressure gauge to measure the working static pressure in the plenum.

5.2 Safety

5.2.1 It shall have adequate provision for fire control.

5.2.2 It shall have adequate protection from or for all moving parts. All rotating parts shall be dynamically balanced.

5.2.3 It shall be provided with features for access to parts during repair, maintenance and operation.

5.2.4 The noise emitted by the heated-air mechanical grain dryer shall not exceed 92 dB (A).

5.2.5 Provision shall be made for dust control. Its dust emission shall be within the acceptable limits set by the Department of Environment and Natural Resources.

6 Workmanship and Finish

6.1 Mechanical grain dryer shall be free from defects that may be detrimental to its use and shall be free from sharp edges and surfaces that may hurt the operator. All metal parts should be machine bend, pressed and cut to avoid rough surfaces and all rough surfaces should be machine finished and smoothed.

6.2 Uniformity of parts and components for same brand and model must be maintained.

7 Warranty for Construction and Durability

7.1 The construction shall be rigid and durable without major breakdown of the following major components: burner, fan, bin and conveying equipment within one (1) year after the date of purchased.

7.2 Warranty shall be provided to parts and services within one (1) year after the date of acceptance of the unit by the user except on fast moving and easy to wear parts such as fan belts.

8 Maintenance and Operation

8.1 Every heated-air mechanical grain dryer unit shall be provided with basic tools, operation and parts manual containing full information on method of installation and operation. The manual which conforms to PAES 102:2000 shall be provided.

8.2 Manufacturer's/ Dealers shall provide after-sales service, identify wearing parts and should provide spare parts.

9 Sampling

The mechanical grain dryer shall be sampled for testing in accordance with PAES 103:2000 – Agricultural Machinery – Method of Sampling.

10 Test Methods

The sampled mechanical grain dryer shall be tested in accordance with PAES 202:2000 – Agricultural Machinery: Heated-Air Mechanical Grain Dryer – Methods of Test.

11 Marking and Labeling

Each unit of mechanical grain dryer shall be marked at a prominent place with the following information:

11.1 Registered trademark of the manufacturer

11.2 Name and address of the manufacturer

11.3 Name and address of the importer

11.4 Country of manufacture/ Made in the Philippines

11.5 Type; Serial number

11.6 Load capacity, tons

11.7 Rated power/voltage/ frequency/ phase, in metric units

11.8 Dry weight in metric units

11.9 Dimension in metric units

11.10 Safety/Precautionary markings