Foreword

The formulation of this national 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 has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards. In compliance with metrication law “Batas Pambansa Bilang 8” enacted on January 1, 1983, some data are converted to International System of Units (SI).

The word “shall” is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

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

Fink, D.G. and H.W. Beaty. *Standard Handbook for Electrical Engineers.* 13th ed. McGraw-Hill International Editions. Electrical Engineering Series. 1993.

Fajardo, M.B. and L.R. Fajardo. *Electrical Layout and Estimate*. 1987

Brown, R.H. *Farm Electrification.* McGraw-hill Book Company.1956.

McPartland J. F. and B.J. McPartland. *National Electrical Code Handbook*. 23rd ed. Conforms to the 1999 NEC. McGraw-Hill International Editions.

A web document on *Application Note: Efficiency Improvements for AC Electric Motors.* Pacific Gas and Electric Company. 1997

A web document on *Electric Motors*. East Carolina University. January 31, 2001.

A web document on *Electric Motor Terminology.* Dreisilker Electric Motors, Inc. 1999-2002.

A web document on *Glossary of Electric Motor Terms.* Winans Electric Motor Repair, Inc. Last updated May 5, 2002.

Republic Act No. 7394 otherwise known as “The Consumer Act of the Philippines” enacted on July 22, 1991.

Agricultural Machinery – Electric Motor – Specifications

1 Scope

This standard establishes specifications and provides sufficient technical information for the appropriate application of electric motor as a source of shaft power for agricultural machinery.

2 References

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

PAES 102:2000, Agricultural Machinery – Operator's Manual – Content and Presentation

PAES 130: 2002, Agricultural Machinery – Electric Motor– Methods of Test

Philippine Electrical Code 2000 Part 1, Vol. 1

National Electrical Manufacturers Association (NEMA) MG 1:1993 – Motors and Generators

Standard Handbook for Electrical Engineers. 13th Edition. 1993

3 Definitions

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

3.1
ampacity
current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating

3.2
disconnecting means
switch
device, or group of devices, or other means by which the electric motor can be disconnected from the power supply

3.3
duty rating
time rating
refers to how frequently the motor is started and how long it will run each time it is started

3.4
electric motor
machine which converts electrical energy to mechanical energy

3.5
enclosure
case or housing which prevents the operator from accidental contact with energized parts and protect the motor from physical damage

3.6
frame designation
standardized motor mounting and shaft dimensions as established by National Electric Manufacturers Association (NEMA) or International Electrotechnical Commission (IEC)

3.7
locked-rotor current
maximum current required to start the motor

3.8
phase
number of individual voltages applied to the motor

3.8.1
three-phase
has three individual voltages applied to the motor

NOTE The three-phase are at 120 degrees with respect to each other so that peaks of voltage occur at even time intervals to balance the power received and delivered by the motor throughout its 360 degrees of rotation.

3.8.2
single-phase
has one voltage applied to the motor in the shape of a sine wave

3.9
rotor
armature winding
rotating part of electric motor which is typically constructed of a laminated steel core containing current-carrying copper wires

3.10
service factor
indicates the maximum load that can be successfully carried by the motor if it is to operate continuously and remain within a safe temperature range

3.11
stator
field poles
stationary part of electric motor consisting of copper windings which is placed in a laminated iron core

3.12
temperature rise
temperature of a motor operating under rated conditions, which is above ambient temperature

3.13
thermal protector
device which protects the motor against overheating due to overload or failure to start

3.14
torque
twisting or turning force produced by the motor

3.14.1
breakdown torque
pull out torque
maximum torque a motor can develop during overload without stalling

3.14.2
starting torque
locked rotor torque
motor torque at zero speed or the maximum torque required to start the load

4 Classification

The classification of electric motors as shown in Figure 1, shall be based on the following:

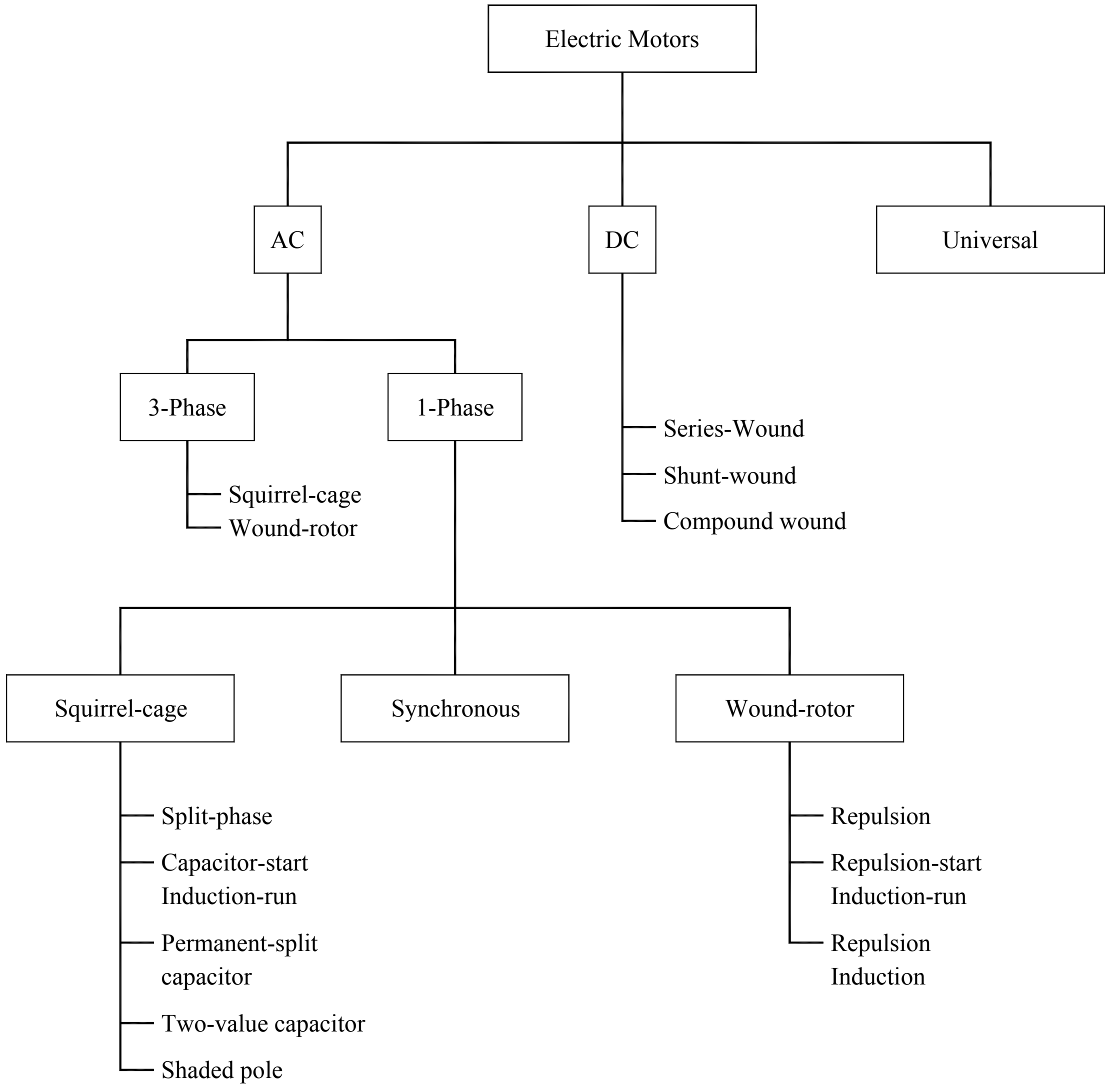

Figure 1 – Classification of Electric Motors

4.1 Current source

4.1.1 Alternating Current (AC) motor

In AC motor, current is sent into the stator winding which is placed in a stationary laminated iron core; the rotating element may or may not be a set of magnet poles.

4.1.1.1 single-phase

Single-phase motor types and their characteristic are shown in Table 1 while full-load current for single-phase AC motors running at usual speed and with normal torque characteristics is shown in Table 2.

Table 1 – Types, Characteristics, and Applications of Single-Phase Motors

Type	Power Ranges		Load-starting Ability	Starting Current	Characteristics	Typical Uses
	kW	hp				
Squirrel Cage:						
Split-phase	0.04 to 0.37	1/20 to 1/2	Easy starting loads. Develops 150% of full-load torque	High; five to seven times full-load current	Nearly constant speed with varying load. Electrically reversible.	Fans, centrifugal pumps, loads that increase as speed increases
Capacitor start	0.09 to 7.46	1/8 to 10	Hard starting loads. Develops 350 to 400 % of full-load torque.	Medium; three to six times full-load current	Nearly constant speed with varying load. Electrically reversible.	Compressors, grain augers, conveyors, pumps, silo unloaders and barn cleaners
Two-value capacitor	1.49 to 14.92	2 to 20	Hard starting loads. Develops 350 to 400 % of full-load torque.	Medium; three to five times full-load current	Nearly constant speed with varying load. Electrically reversible.	Conveyors, barn cleaners, elevators, silo unloaders
Permanent-split capacitor	0.04 to 0.75	1/20 to 1	Easy starting loads. Develops 150% of full-load torque	Low; two to four times full-load current	Electrically reversible.	Fans and blowers
Shaded pole	0.003 to 0.37	1/250 to 1/2	Easy starting loads.	Medium	Not electrically reversible.	Small blowers, fans and small appliances
Wound-rotor (repulsion)	0.12 to 7.46	1/6 to 10	Very hard starting loads. Develops 350 to 400 % of full-load torque.	Low; two to four times full-load current	Not electrically reversible. Reversed by brush ring readjustment.	Conveyors, drag burr mills, deep-well pumps, hoists, silo unloaders, bucket elevators

Adapted from Standard Handbook for Electrical Engineers, 13th Ed. 1993

NOTE Some power companies may limit size of motor to be connected to single-phase lines.

Table 2 – Full-Load Current for Single-Phase and Three-Phase Alternating Current Motors

Power		Full-load current at 230 Volts Amperes	
kW	**hp**	**Single-phase**	**Three-phase**
0.12	1/6	2.2	-
0.19	1/4	2.9	-
0.25	1/3	3.6	-
0.37	1/2	4.9	2.2
0.56	3/4	6.9	3.2
0.75	1	8.0	4.2
1.12	1 1/2	10.0	6.0
1.49	2	12	6.8
2.24	3	17	9.6
3.73	5	28	15.2
5.60	7 1/2	40	22
7.46	10	50	28
11.19	15	-	42
14.92	20	-	54
18.65	25	-	68
22.38	30	-	80
29.84	40	-	104

Adapted from Philippine Electrical Code 2000 Part 1, Vol.1

4.1.1.2 three-phase

Three-phase motor types and their characteristic are shown in Table 3 while full-load current for three-phase AC motors running at usual speed and with normal torque characteristics is shown in Table 2.

Table 3 – Types, Characteristics, and Applications of Three-Phase Motors

Type	Description	Starting Torque	Maximum Running Torque	Characteristics	Typical Uses
Squirrel Cage	NEMA Design B: Energy efficient; Normal starting current; can be used with variable frequency or variable-voltage inverters; higher efficiency than standard-design B motors	100 – 150 % of full-load torque	200 – 250 % of full-load torque	Continuous operation, constant speed, high speed (over 720 rpm), easy starting; subject to short time overloads; good speed regulation	Pumps; compressors, conveyors, process machinery
	NEMA Design B: Normal torques; Normal starting current; can be used with variable-frequency or variable-voltage inverters;	100 – 150 % of full-load torque	200 – 250 % of full-load torque	Variable load conditions, constant speed; subject to short time overloads; good speed regulation	Centrifugal pumps, blowers, fans, drilling machines, grinders, lathes, compressors, conveyors
	NEMA Design C: High torque; Normal starting current; not recommended for use with variable-frequency inverters	200 – 300 % of full-load torque	Not more than full-load torque	High starting torque; not subject to severe overloads; good speed regulation	Reciprocating fans, stokers, compressors, crushers, ball and rod mills
	NEMA Design D: High torque; High slip; standard types have slip characteristics of 5 - 8% or 8 - 13% slip	Up to 300 % of full-load torque	200 – 300 % of full-load torque; loss of speed during peak loads required	Intermittent loads; poor speed regulation to smooth power peaks	Punch presses, cranes, hoists, press brakes, shears, centrifugals
	Multispeed:Normal torque on dominant winding or speed; consequent pole windings or separate windings for each speed; based on load requirement, can be constant horsepower, constant torque, variable torque	Some require low torque; others require several times full-load torque	200 % of full-load torque at each speed	Low starting torque and variable torque on blowers. High starting toque and constant torque on conveyors	Blowers, fans, machine tools, mixing machines, conveyors, pumps
Wound-rotor	Requires rotor control system to provide desired characteristic; control may be resistors or reactors or fixed-frequency inverters in the secondary (rotor) circuit; actual load speed depends on the setting of rotor control	Can provide torque up to maximum torque at standstill	200 – 300 % of full-load torque	Very high starting torque with low starting current; limited range of speed adjustments; controlled acceleration	Crushers, conveyors, bending rolls, ball and rod mills, pumps, centrifugal blowers, cranes and hoists, centrifugals

Adapted from Standard Handbook for Electrical Engineers, 13th Ed. 1993

4.1.2 Direct current (DC) motor

In the DC motor, current is sent into the armature winding, which is placed in-between a set of radially supported magnet poles.

4.1.3 Universal motor

Universal motors are small series motors up to 3.73 kW rating which are commonly designed to operate on either direct current or alternating current.

4.2 Construction

4.2.1 Shunt-wound motor

A type of DC motor, in which the field winding is connected in parallel with the armature.

NOTE: The shunt motor is used in constant speed application.

4.2.2 Series-wound motor

A type of DC motor, in which the field winding is connected in series with the armature.

NOTE The series motor is used in applications where a high starting torque is required.

4.2.3 Compound-wound motor

A type of DC motor, which has a series-field and shunt-field winding.

NOTE In compound motor, the drop of the speed-torque characteristics may be adjusted to suit the load.

4.2.4 Synchronous

A type of AC motor capable of raising the power factor of systems having large induction-motor loads.

4.2.5 Wound-rotor

A type of AC motor, wherein secondary windings are wound with discrete conductors with the same number of poles as the primary winding on the stator.

4.2.6 Squirrel-cage

A type of AC motor wherein the rotor or secondary winding consists merely of 28 identical copper or cast-aluminum bars solidly connected to conducting end wings on each end, thus forming a “squirrel-cage” structure.

The starting kVA of a squirrel-cage motor is indicated by a code letter stamped on the nameplate. Table 4 shows the corresponding kVA for each code letter.

Table 4 – Motor Code Letters

Letter Designation	kVA per Horsepower	Letter Designation	kVA per Horsepower
A	below 3.15	L	9.0 – 9.99
B	3.15 – 3.54	M	10.0 – 11.19
C	3.55 – 3.99	N	11.2 – 12.49
D	4.00 – 4.49	P	12.5 – 13.99
E	4.50 – 4.99	R	14.0 – 15.99
F	5.00 – 5.59	S	16.0 – 17.99
G	5.60 – 6.29	T	18.0 – 19.99
H	6.30 – 7.09	U	20.0 – 22.39
J	7.10 – 7.99	V	22.4 and up
K	8.00 – 8.99		

Source: Philippine Electrical Code 2000 Part 1, Vol.1

4.3 Starting

4.3.1 Split-phase

In split-phase motor, torque can be obtained by providing a separate winding, or auxiliary phase 90º displaced in space from the main winding. The typical schematic diagram of a split-phase motor is shown in Figure 2.

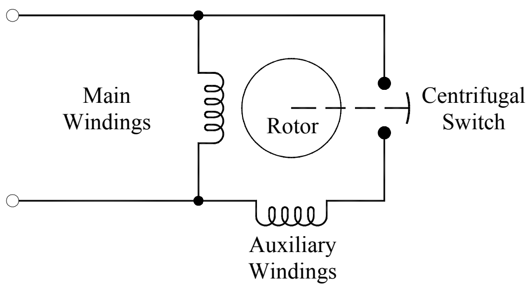

Figure 2 – Split-phase Motor Diagram

4.3.2 Capacitor-start induction-run

In capacitor-start, induction-run motor, torque can be obtained by inserting an external series capacitor in the auxiliary winding circuit, which is opened by a centrifugal switch or relay as the motor approaches full speed. The typical schematic diagram of a capacitor-start induction-run motor is shown in Figure 3.

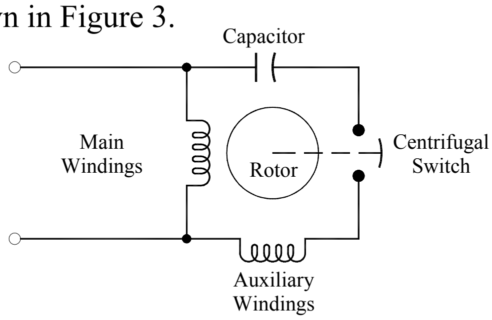

Figure 3 – Capacitor-start Induction-run Motor Diagram

4.3.3 Permanent split-capacitor

In permanent split-capacitor motor, torque can be obtained by inserting an external series capacitor permanently in the circuit. The typical schematic diagram of a permanent split-capacitor motor is shown in Figure 4.

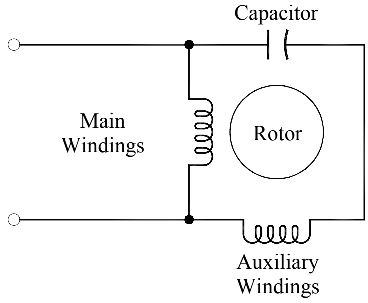

Figure 4 – Permanent Split-Capacitor Motor Diagram

4.3.4 Two-value capacitor

In two-value capacitor motor, torque can be obtained by retaining the auxiliary winding in circuits with a reduced capacitor size in parallel with a small oil capacitor at starting and cutting the former out of circuits with a centrifugal switch or relay when the motor approaches full speed. The typical schematic diagram of a two-value capacitor motor is shown in Figure 5.

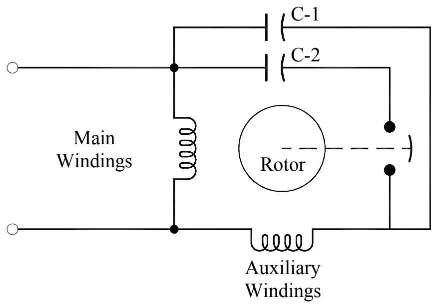

Figure 5 – Two-value Capacitor Motor Diagram

4.3.5 Shaded pole

In shaded pole motor, the current is induced in an auxiliary winding called shading coil. Shaded-pole motors are used only in very small sizes normally below 50 W output. The typical schematic diagram of a shaded pole motor is shown in Figure 6.

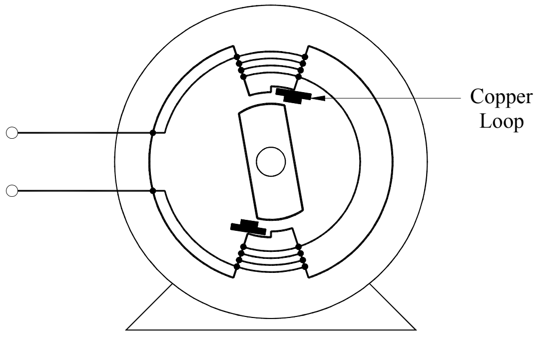

Figure 6 – Shaded Pole Motor Diagram

4.3.6 Repulsion

In repulsion, torque can be obtained by providing a winding and commutator on the rotor, with a single pair of short-circuited brushes for starting and a centrifugal mechanism which short-circuits the entire commutator as the motor approaches full speed. The typical schematic diagram of a wound-motor (repulsion) is shown in Figure 7.

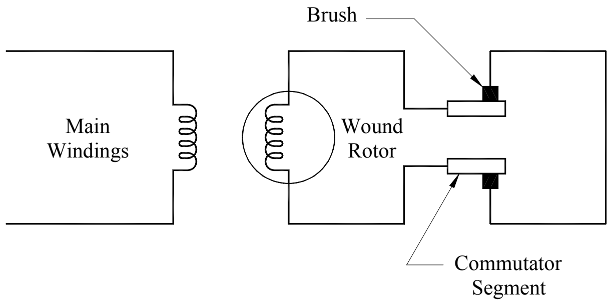

Figure 7 – Wound-motor (Repulsion) Motor Diagram

4.4 Other classification

4.4.1 Size

4.4.1.1 Fractional-horsepower

A type of motor built in smaller frames having a continuous rating of less than 1 hp, open type, at 1700 rpm to 1800 rpm.

4.4.1.2 Integral-horsepower

A type of motor built in larger frames having a continuous rating equal to and greater than 1 hp, open type, at 1700 rpm to 1800 rpm.

Integral-horsepower motors are classified according to locked-rotor and breakdown torque which are developed and locked rotor currents drawn, and are identified by NEMA design letters A, B, C, D and F as shown in Table 5.

Table 5 –Design Letters for Integral-horsepower motors

Design Letter	Starting Torque	Breakdown Torque	Starting Current	Slip at Rated Load	Typical Application
A	Normal	High	Normal	Low	Machine tools, centrifugal pumps, fans
B	Normal	High	Low	Low	Same as design A
C	High	Normal	Low	Low	Loaded compressor
D	Very High	N/A	Low	High	Punch presses
F	Low	Very Low	Very Low	Above Normal	Large fans

Source: National Electrical Manufacturers Association (NEMA) MG 1-1.16

4.4.2 Duty rating

4.4.2.1 Intermittent

In intermittent rating, the motor is to be used for less than one hour each time and followed by a period of rest. The ratings used are 5, 15, 30, and 60 minutes.

4.4.2.2 Continuous rating

In continuous rating, the motor is to be used for more than one hour.

4.4.3 Temperature rating

The temperature rise shall not exceed the limit for the insulation class when the motor is loaded to its rating or its service factor load. Table 6 shows the maximum temperature for each insulation class.

Table 6 – Insulation Class of Motors

Insulation Class	**Maximum Hot Spot Continuous Temperature**	
	°C	**°F**
A	105	221
B	130	266
F	155	311
H	180	356

Source: Standard Handbook for Electrical Engineers, 13th Ed. 1993

4.4.4 Service factor

The standard service factors are shown in Table 7.

Table 7 – Service Factor of Motors

Service Factor	**Power rating**	
	kW	**hp**
1.40	0.04 to 0.09	1/20 to 1/8
1.35	0.12 to 0.25	1/6 to 1/3
1.25	0.37 to 0.75	1/2 to 1
1.15	>0.75 to 149.20	>1 to 200
1.00	>149.20 to 373	>200 to 500

Source: Standard Handbook for Electrical Engineers, 13th Ed. 1993

4.4.5 Enclosure

The type of enclosure, which has been standardized by the NEMA, is shown in Table 8.

Table 8 – Standard Enclosure Types and their Characteristics

Types	Characteristics
Open:	
Drip-proof	Operate with dripping liquids up to 15° from vertical
Splash-proof	Operate with splashing liquids up to 100° from vertical
Guarded	Guarded by limited size openings (less than 19 mm.)
Semiguarded	Only top half of motor is guarded.
Drip-proof, fully guarded	Drip-proof motor with limited size openings
Externally ventilated	Ventilated with separate motor-driven blower; can have other types of protection
Pipe ventilated	Openings accept inlet ducts or pipe for air cooling
Weather protected, Type 1	Ventilating passages minimize entrance of rain, snow, and airborne particles. Passages are less that 19 mm. in diameter.
Weather protected, Type 2	Motors have, in addition to type 1, passages to discharge high-velocity particles blown into the motor
Totally Enclosed:	
Nonventilated (TENV)	Not equipped for external cooling
Fan-cooled (TEFC)	Cooled by external integral fan
Explosion-proof	Withstands internal gas explosion; prevents ignition of external gas
Dust-ignition -proof	Excludes ignitable amounts of dust and amounts of dust that would degrade performance
Water-proof	Excludes leakage except around shaft
Pipe ventilated	Openings accept inlet ducts or pipe for air cooling
Water-cooled	Cooled by circulating water
Water-and-air-cooled	Cooled by water-cooled air
Air-to-air-cooled	Cooled by air-cooled air
Guarded TEFC	Fan cooled and guarded by limited-size openings
Encapsulated	Has resin-filled windings for severe operating conditions

Source: Standard Handbook for Electrical Engineers, 13th Ed. 1993

5 Performance Requirements

5.1 Motor efficiencies

Motor efficiencies and power factors shall meet or exceed the following values to conform with Philippine Electrical System at ±10% 230 volts and 60 Hz frequency.

Table 9 – Motor Efficiency at Different Power Ratings

Power		Efficiency	Power Factor
kW	hp	%	
0.75	1	84.0	0.74
1.12	1.5	84.0	0.74
1.49	2	84.0	0.74
2.24	3	87.5	0.75
3.73	5	87.5	0.75
5.60	7.5	89.5	0.78
7.46	10	90.2	0.80
11.19	15	91.1	0.82
14.92	20	92.0	0.82
18.65	25	92.4	0.82
22.38	30	92.5	0.83
29.84	40	93.1	0.84
37.30	50	93.1	0.84
44.76	60	93.7	0.84
55.95	75	94.2	0.85
74.60	100	94.6	0.85
93.25	125	94.6	0.85
111.90	150	95.1	0.86
149.20	200	95.1	0.86
over 149.20	over 200	95.4	0.86

Source: NEMA Standard MG1

6 Other Requirements

6.1 Wires and overcurrent devices

Wire sizes and overcurrent devices (fuse and circuit breaker) shall be selected according to the load to be carried and shall conform to Philippine Electrical Code 2000 Article 3.10 – Conductors for General Wiring.

NOTE: For details on the selection of wires and overcurrent devices, refer to Annex A.

6.2 Disconnecting means

Switches capable of disconnecting motors from the circuit shall conform to the Philippine Electrical Code 2000 Article 4.30 Section 10 – Disconnecting Means.

6.3 Grounding

The grounding of exposed noncurrent-carrying metal parts of electric motor shall conform to Philippine Electrical Code 2000 Article 4.30 Section 13 – Grounding – All Voltages.

6.4 Power delay device (optional)

A power delay device, which protects the electric motor from surges of electricity, as well as low and high voltages, shall be provided.

7 Mounting

The mounting specifications of an electric motor is defined by its Frame Number as shown in Table 10 and illustrated in Figure 8.

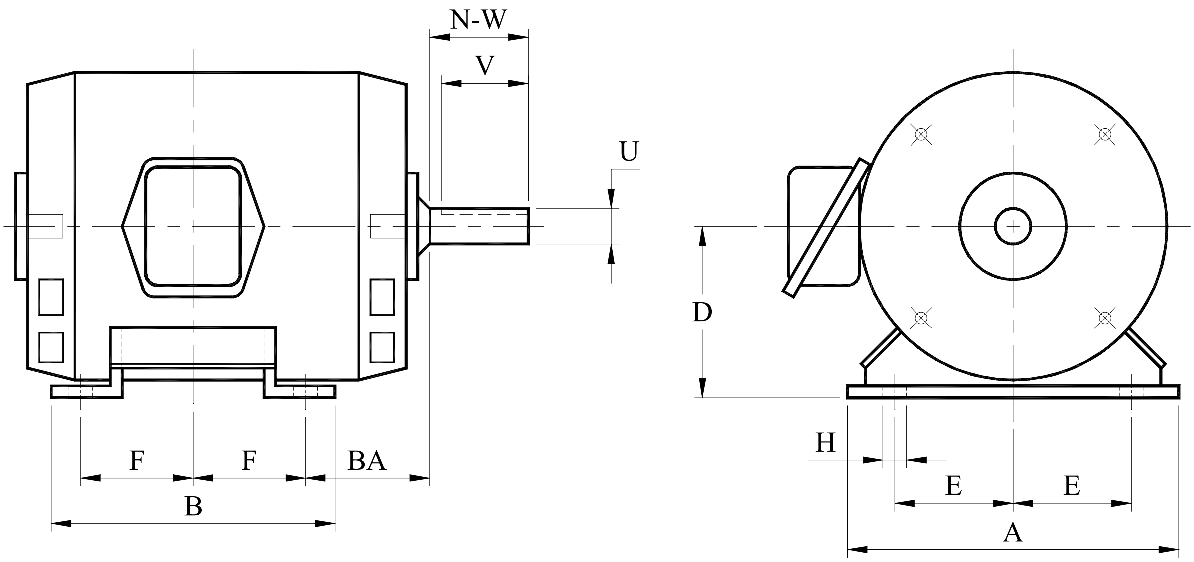

Figure 8 – Mounting Dimensions

Table 10 – Dimensions for Foot-Mounted Electric Motor

	Dimension, mm												
Frame	**A**	**B**	**D**	**E**	**F**	**BA**	**H**	**N-W†**	**U†**	**V†**	Key		
Number	**max**	**max**									**Width†**	**Thickness†**	**Length†**
42	-	-	67	44	21	52	7	29	10			1	
48	-	-	76	54	35	64	9	38	13			1	
48H	-	-	76	54	60	64	9	38	13			1	
56	-	-	89	62	38	70	9	48	16		5	5	35 §
56H	-	-	89	62	64	70	9	48	16		5	5	35 §
66	-	-	105	75	64	79	10	57	19		5	5	48 §
143, T	178	152	89	70	51	57	9	51, 57	19, 22	44, 51	5, 5	5, 5	35, 35
145, T	178	152	89	70	64	57	9	51, 57	19, 22	44, 51	5, 5	5, 5	35, 35
182, T	229	165	114	95	57	70	10	57, 70	22, 29	51, 64	5, 6	5, 6	35, 44
184, T	229	191	114	95	70	70	10	57, 70	22, 29	51, 64	5, 6	5, 6	35, 44
213, T	267	191	133	108	70	89	10	76, 86	29, 35	70, 79	6, 8	6, 8	51, 60
215, T	267	229	133	108	89	89	10	76, 86	29, 35	70, 79	6, 8	6, 8	51, 60
254U, T	318	273	159	127	105	108	13	95, 102	35, 41	89, 95	8, 10	8, 10	70, 73
256U, T	318	318	159	127	127	108	13	95, 102	35, 41	89, 95	8, 10	8, 10	70, 73
284U, T	356	318	178	140	121	121	13	124, 117	41, 48	117, 111	10, 13	10, 13	95, 95
284TS	356	318	178	140	121	121	13	83	41	76	10	10	48
286U, T	356	356	178	140	140	121	13	124, 117	41, 48	117, 111	10, 13	10, 13	95, 95
286TS	356	356	178	140	140	121	13	83	41	76	10	10	48
324U, T	406	356	203	159	133	133	17	143, 133	48, 54	137, 127	13, 13	13, 13	108, 98
324S, TS	406	356	203	159	133	133	17	83, 95	41, 48	76, 89	10, 13	10, 13	48, 51
326U, T	406	394	203	159	152	133	17	143, 133	48, 54	137, 127	13, 13	13, 13	108, 98
326S, TS	406	394	203	159	152	133	17	83, 95	41, 48	76, 89	10, 13	10, 13	48, 51
364U, T	457	387	229	178	143	149	17	162, 149	54, 60	156, 143	13, 16	13, 16	127, 108
364US, TS	457	387	229	178	143	149	17	95, 95	48, 48	89, 89	13, 13	13, 13	51, 51
365U, T	457	413	229	178	156	149	17	162, 149	54, 60	156, 143	13, 16	13, 16	127, 108
365US, TS	457	413	229	178	156	149	17	95, 95	48, 48	89, 89	13, 13	13, 13	51, 51
404U, T	508	413	254	203	156	168	21	181, 184	60, 73	175, 178	16, 19	16, 19	140, 143
404 US, TS	508	413	254	203	156	168	21	108, 108	54, 54	102, 102	13, 13	13, 13	70, 70
405U, T	508	451	254	203	175	168	21	181, 184	60, 73	175, 178	16, 19	16, 19	140, 143
405US, TS	508	451	254	203	175	168	21	108, 108	54, 54	102, 102	13, 13	13, 13	70, 70
444U, T	559	470	279	229	184	191	21	219, 216	73, 86	213, 210	19, 22	19, 22	178, 175
444US, TS	559	470	279	229	184	191	21	108, 121	54, 60	102, 114	13, 16	13, 16	70, 76
445U, T	559	521	279	229	210	191	21	219, 216	73, 86	213, 210	19, 22	19, 22	178, 175
445US, TS	559	521	279	229	210	191	21	108, 121	54, 60	102, 114	13, 16	13, 16	70, 76
504U	635	533	318	254	203	216	24	219	73	213	19	19	184
504S	635	533	318	254	203	216	24	108	54	102	13	13	70
505	635	584	318	254	229	216	24	219	73	213	19	19	184
505S	635	584	318	254	229	216	24	108	54	102	13	13	70

Adapted from NEMA Standard MG1.

† Second value, where present, is for rerated T frames. Values for frames 143T through 326TS are final; values for 364T through 445TS are tentative.

§ Effective length of keyway.

8 Workmanship and Finish

8.1 The electric motor shall be free from manufacturing defects that may be detrimental to its operation.

8.2 The electric motor shall be free from sharp edges and surfaces that may injure the operator.

9 Warranty for Construction and Durability

9.1 Warranty against defective materials and workmanship shall be provided for parts and services within six (6) months from the purchase of the electric motor.

9.2 The construction shall be rigid and durable without breakdown of its major components within six (6) months from purchase by the first buyer.

10 Maintenance and Operation

10.1 An operator's manual, which conforms to PAES 102, shall be provided.

11 Sampling

Electric motor shall be sampled in accordance with PAES 103.

12 Test Method

Sampled electric motor shall be tested for performance in accordance with PAES 130.

13 Marking and Labeling

Each AC single-phase or three-phase electric motors shall be marked in English language with the following information using a plate, stencil or by directly punching it at the most conspicuous place:

13.1 Registered trademark of the manufacturer

13.2 Brand

13.3 Model

13.4 Motor serial number

13.5 Name and address of the manufacturer

13.6 Country of manufacture (if imported) / "Made in the Philippines" (if manufactured in the Philippines)

13.7 Rated output power

13.8 Rated voltage and full-load amperes

13.9 Rated frequency and number of phases

13.10 Rated full-load speed

13.11 Rated temperature rise

13.12 Duty/time rating

13.13 Motor code letter (See Table 4)

13.14 Design letters for integral-horsepower motors (See Table 5)

13.15 Insulation (See Table 6)

13.16 Service factor (See Table 7)

13.17 Frame designation (See Table 10)

13.18 Bearings

13.19 Thermal or overload protection

13.20 Direction for changing voltage or for reversing direction of rotation

Annex A
(informative)

Wiring Design Example

Given a 25 hp, three-phase, 230-volt, squirrel cage induction motor. The ambient temperature of the place of installation is 40°C. Use TW wires.

Required: Determine the full-load current, size conductor (wire), and overcurrent devices rating.

Solution:

1. From Table 2, a 25-hp squirrel-cage three-phase AC motor has a full-load current of 68 Amperes at 230 volts.

2. From Philippine Electrical Code 2000, Article 4.30 Section 2.2 (a), *"Branch-circuit conductors that supply a single motor used in a continuous duty application shall have an ampacity of not less than 125 percent of the motor's full-load current rating."*

$$Ampacity = Full\ load\ current\ x\ 125\% = 68\ x\ 1.25 = 85\ Amperes(minimum)$$

Using Table A1, under TW wire type, find the ampacity of the conductor, which when multiplied to correction factor for ambient temperature will equal or exceed the computed value of 85 Amperes. The ampacity of 50 mm^2 TW copper wire at 40°C ambient is 120 Amperes x 0.82 = 98.4 Amperes. Note that 0.82 is equal to the correction factor at 40°C ambient temperature. Therefore, use three 50 mm^2 TW copper wires.

3. Using the ampacity of the conductor computed in 2, find the nearest standard fuse/breaker rating from Table A2. Therefore, use 200-Ampere Fuse or Circuit Breaker.

Table A1 – Allowable Ampacities of Insulated Conductors Rated 0 through 2,000 Volts, 60°C Through 90°C not more than Three Current-Carrying Conductors in Raceways, Cable, Based on Ambient Temperature of 30°C

Conductor Size [mm²]	Temperature Rating of Conductor					
	60°C	75°C	90°C	60°C	75°C	90°C
	Types TW, UF	Types FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, ZW-2, RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2	Types TW, UF	Types RH, RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW_2, THWN-2, USE-2, XHH, XHHW, ZW-2, XHHW-2
	COPPER			ALUMINUM or COPPER-CLAD ALUMINUM		
2.0	20	20	25	--	--	--
3.5	25	25	30	20	20	25
5.5	30	35	40	25	30	35
8.0	40	50	55	30	40	45
14	55	65	70	40	50	65
22	70	85	90	55	65	80
30	90	110	115	65	80	90
38	100	125	130	75	90	105
50	**120**	145	150	95	110	125
60	135	160	170	100	120	135
80	160	195	205	120	145	165
100	185	220	225	140	170	190
125	210	255	265	165	200	225
150	240	280	295	185	225	250
200	280	330	355	220	265	300
250	315	375	400	255	305	345
325	370	435	470	305	365	410
400	405	485	515	335	405	460
500	445	540	580	370	440	495
CORRECTION FACTOR						
Ambient Temp. (°C)	For ambient temperatures other than 30°C, multiply the allowable ampacities shown above by the appropriate factor shown below					
21 – 25	1.08	1.05	1.04	1.08	1.05	1.04
26 – 30	1.00	1.00	1.00	1.00	1.00	1.00
31 – 35	0.91	0.94	0.96	0.91	0.94	0.96
36 – 40	**0.82**	0.88	0.91	0.82	0.88	0.91
41 – 45	0.71	0.82	0.87	0.71	0.82	0.87
46 – 50	0.58	0.75	0.82	0.58	0.75	0.82
51 – 55	0.41	0.67	0.76	0.41	0.67	0.76
56 – 60	--	0.58	0.71	--	0.58	0.71
61 – 70	--	0.33	0.58	--	0.33	0.58
71 – 80	--	--	0.41	--	--	0.41

Source: Philippine Electrical Code 2000 Part 1, Vol. 1

Table A2 – Standard Ampere Rating for Fuses and Circuit Breaker

Fuse and Circuit Breaker Rating Ampere	Maximum Load Ampere
15	8
30	12
50	20
60	24
70	28
80	32
90	36
100	40
110	44
125	50
150	60
175	70
200	***80***
225	90
250	100
300	120
350	140
400	160
450	180
500	200
600	240
700	280
800	320
1000	400
2000	800
3000	1200