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This document is a summary of recommendations against which to check...

## AC Electric Motors best practice

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### Manufacturing

#### **Design/construction related features in ac motors that lead to longer service life and higher productivity [1]**

Engineers must select a proper motor that meets rms torque requirements.

Oversized motors add inertia that must be started and stopped frequently.

A properly selected winding increased the life of all other components.

Motors designed for long life use bearing lubricants applicable to the machines operating temperature class.

#### **How can designers optimize service life and productivity when selecting and applying ac motors [1]**

If an application demands several starts and stops then the peak current must be considered due to heat generated in the windings. This heat must be removed from the motor through its surface, but amount dissipated depends on the ambient surroundings.

Elevated temperatures can also be a reflection of the load to rotor inertia. One way to reduce this inertia mismatch is by adding ratio via a gearbox.

Successful motor operation depends on defining application speed, torque, reflected inertia, and time.

#### **Motor efficiency standards [2]**

Many different energy efficiency standards for IMs are currently in use (e.g. NEMA and EPAct in USA, CSA in Canada, CEMEP/EU in Europe, AS/NZ in Australia and New Zealand, JIS in Japan, and GB in China) with new classes currently being developed in several countries around the world.

It becomes increasingly difficult for manufacturers to design motors for a global market and for customers to understand differences and similarities of standards in different countries. In order to overcome those undesirable situations, a new international standard is being developed by the IEC, IEC



60034-30. Four efficiency classes are proposed, namely Standard Efficiency (IE1), High Efficiency (IE2) equivalent to EPAct, Premium Efficiency (IE3), and Super-Premium Efficiency (IE4).

TABLE I  
 SINGLE-SPEED IM CHARACTERISTICS FOR DIFFERENT MOTOR EFFICIENCY RELATED STANDARDS.

Minimum Efficiency Standard or Voluntary Agreement	Pole Pairs	Duty Type	Power Range	$f_N$ (Hz)	$U_N$ (V)	Design Type	Efficiency Testing Standard
CEMEP-EU	1, 2	S1 <sup>a</sup>	1.1-90 kW	50	400	N <sup>c</sup>	IEC 60034-2, Ed.2 <sup>e</sup>
IEC 60034-30	1-3	S1, S3 <sup>b</sup>	0.75-370 kW	50/60	≤ 1k	N <sup>c</sup>	IEC 60034-2-1 <sup>f</sup>
EPAct	1-3	S1	1-200 hp	60	460	A, B <sup>d</sup>	IEEE 112-B
NEMA MG 1 - 2003 & NEMA 12-6C	1-3	S1	1-500 hp	60	≤ 600	A, B <sup>d</sup>	IEEE 112-B
AS 1359.5	1-4	S1	0.73-185 hp	50	≤ 1k	--	AS 1359.102 <sup>g</sup>
GB 18613, 2006	1-3	--	0.55-315 kW	50	≤ 690	N <sup>h</sup>	GB/T 1032 <sup>g</sup>

**Notes:**

- <sup>a</sup> S1 - Continuous duty/rated;
- <sup>b</sup> S3 - Intermittent periodic duty, with an operation time of 80% or more;
- <sup>c</sup> According to IEC 60034-12 Standard;
- <sup>d</sup> According to NEMA;
- <sup>e</sup> Summation of losses, SLLs assumed 0.5% of input power;
- <sup>f</sup> Summation of losses, SLLs determined either from residual loss test;
- <sup>g</sup> Two methods allowed: AS 1359.102.3 (similar to IEEE 112-B) and AS 1359.102.1 (similar to IEC 60034-2, Ed. 2).
- <sup>h</sup> According to GB 755-2000 Std.

## Assembly

Ensure all mating parts are clean. Cleaning can be done with a magnet, vacuum cleaner or dry compressed air [3]

## Installation

### Choice of Voltage [4]

Accepted good practice is to keep the difference in voltage between the point at which power is and the motor terminals below 3 percent when the motor is delivering full load delivered from the utility.

Nominal Voltage (V)	Nameplate voltage (V)	
	Polyphase Motors	Single-phase motors
120	110	115
120/208	208 or 220	115
240	220	230
480	440	460
600	550	-
2400	2300	-

### Preferred Motor nameplate voltages [4]

Data based on recommendation by EEI and NEMA that equipment is intended to be used on the system whose nominal voltage is associated with, but is not numerically equal to, its rating (for example, a motor rated 220 volts on a nominal 240 volt system).

## Foundations [5]

A rigid foundation is essential for minimum vibration and proper alignment between motor and load.

## Mounting [5]

A motor can be mounted in many ways, depending upon its size, weight, and use. Small motors may incorporate a rigid mount, with the frame welded directly to a steel plate formed to match the shape of

the frame and incorporating mounting holes. Most commonly, medium- and large-size motors have mounting feet cast integrally with their frames. Vertical motors require an end bell specially machined to receive a mounting flange. Where it's important to isolate vibration and noise or to reduce the shock of starting and stopping, various types of resilient mounts and cushion bases are available.

After aligning the motor with the load, you can bolt the motor in place with maximum size bolts. It's advisable to provide some dimensional variance in the location of the foundation bolts. This can be done by locating the bolts in a steel pipe embedded in the foundation. NEMA standards give dimensions for foot mountings and some flange mountings. Sliding bases and adapters are available for use with T-frame motors when they replace old U-frame motors. Make sure you check whether other components or equipment such as gears, special couplings, or pumps are to be mounted on the motor. If so, be sure space is available.

After the motor base is in place but before it is fastened, you should shim as required to level the base. Use a spirit level (check two directions at 90 degrees) to ensure that motor feet will be in one plane (base not warped) when base bolts are tightened. Then, set the motor on the base, install nuts, and tighten. Do not make a final tightening until after alignment.

## **Operating**

### **How can end users optimize service life and productivity from the ac motors on their machines [1]**

Users must pay attention to their motor bearings to prevent premature failure. This involves re-greasing with compatible grease as defined by the manufacturer.

Strict adherence to shaft alignment and motor mounting procedures reduce shaft breakage, vibration, and bearing failure.

Routine maintenance every 6 months ensures the surrounding area has not degraded. Make sure all protected guards, gaskets and other protective means are in good working order.

## **Maintenance**

### **Visual and mechanical inspections [6]**

An important aspect of large machine maintenance is the visual and mechanical inspection.

1. Inspect the machine's physical and mechanical condition.

- Check for signs of oil or water leakage.
- Verify that air inlets are not plugged.
- Check for abnormal sounds or smells.
- Check the water and oil supply piping.



- Check the drain piping.
  - Look at the condition of the foundation, grout, bed plates, anchor bolts, shaft extensions, couplings and guards.
  - Check the surroundings for any environmental issues that may affect performance or service life.
2. Inspect anchorage, alignment and grounding of the motor, driven equipment and base.
  3. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.
  4. Inspect bolted electrical connections for high resistance.
  5. While the unit is under full load, perform a thermographic survey.
  6. Perform special tests such as air-gap spacing and machine alignment, if applicable.
  7. Verify the application of appropriate lubrication and lubrication systems.
    - Verify the bearing oil level.
    - Check for improper lubrication, oil of the wrong type, viscosity that is too heavy or too light.
    - Verify that there is sufficient oil in bearing bracket to cover bottom of rings.
    - Look for dirty oil or old oil (should be replaced and/or tested).
    - Verify that the oil rings are turning (especially at low temperatures).
    - Check for water or other contamination within the lubrication system.
    - Verify that the feed oil is connected to the correct ports When the bearing and seals are inspected the following should be considered:
      - Check for excessive bearing clearance.
      - Verify seal clearance and condition.
      - Make sure there is not improper seating of shaft journal in bearing or a bent shaft.
  8. Verify the absence of unusual mechanical or electrical noise or signs of overheating.
    - Check for pitting of bearing and journal surfaces due to bearing currents.
    - Verify integrity of bearing insulation.
    - Make sure there are no rough bearing surfaces due to corrosion or careless handling.
    - Verify that there is not excessive end thrust from the mechanical load.

- Check for poor alignment.
- Make sure that the bearing Babbitt has not been fractured or damaged due to impact or shock loading of the bearing journal.

9. Verify that resistance temperature detector (RTD) circuits conform to drawings and are functioning properly.

### **Electrical tests for AC induction motors [6]**

Electrical tests performed on large motors can yield significant information as to the overall health of the machine.

Some of the more common electrical tests and procedures include:

1. Resistance measurements taken through bolted connections with a low-resistance ohmmeter;
2. Insulation-resistance tests in accordance with ANSI/IEEE Standard 43;
3. DC overpotential tests on machines rated at 2300 volts and greater in accordance with ANSI/IEEE Standard 95;
4. Phase-to-phase stator resistance tests on machines 2300 volts and greater;
5. Insulation power-factor or dissipation-factor tests;
6. Power-factor tip-up tests;
7. Surge comparison tests;
8. Insulation-resistance tests on insulated bearings;
9. Testing and inspection of surge protection devices;
10. Testing and inspection of motor starters;
11. Resistance tests on resistance temperature detector (RTD) circuits;
12. Verification of machine space heater operation, if applicable;
13. Vibration testing of motor after it has started running.

### **Possible relevant standards**

<b>Standard No.</b>	<b>Title.</b>	<b>What it covers.</b>
NEMA MG 1-2.02	Motors and Generators	Assists users in the proper selection and application of motors and generators. Practical information concerning performance, safety, test, construction and manufacture of ac and dc motors and generators.

NEMA MG 1-2.05	Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors	Provides practical information concerning proper selection and application of polyphase induction and synchronous motors, including installation, operation and maintenance.
ANSI/NETA MTS-2007	Standard for Maintenance Testing Specifications for Electrical Distribution Equipment and Systems	

## References

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