ELECTRIC POWER
RESEARCH INSTITUTE

Technology Reference Guide to Electric Motors 3Rs: Repair, Rewind, Replace

Technical Brief

OVERVIEW

The purpose of this document is to help inform the difficult decision of how to address aging/failing motors and when to do it. There are many questions to consider to determine whether a motor should be repaired, rewound, or replaced. The most common questions are often:

1. When a motor fails, is it better to repair or replace it?
2. Can a repaired or rewound motor retain its efficiency rating?

This guide will provide answers to these questions and provide a step-by-step reference guide for assessing motor failure and determining the best course of action.

Note: Practices for high efficiency EPAct (IE2) or NEMA Premium® (IE3) motors are the same.

A MOTOR HAS FAILED – WHERE DO YOU START?

A motor has failed. There are numerous critical questions to ensure that the steps taken to fix the problem result in the best efficiency for the lowest cost, both short-term and long-term. In Figure 2 all the immediate questions have been arranged into a flow chart that will guide you to either repairing the motor, or replacing it.

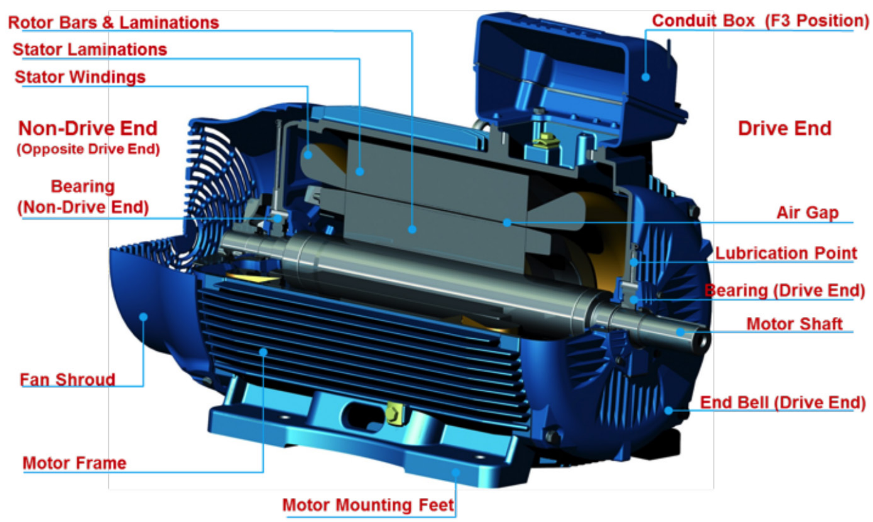


Figure 1 – Diagram of on AC Motor (Source: Hydraulic Institute)

Step 1 – Reassess the Motor Application

Examine the motor and determine if the motor is suitable for the application. If the motor is completely covered in dust/debris or dripping with moisture, an enclosed motor may be more applicable. Sometimes the requirements of the motor can change over time, and the motor is no longer ideal for the application.

Actions:

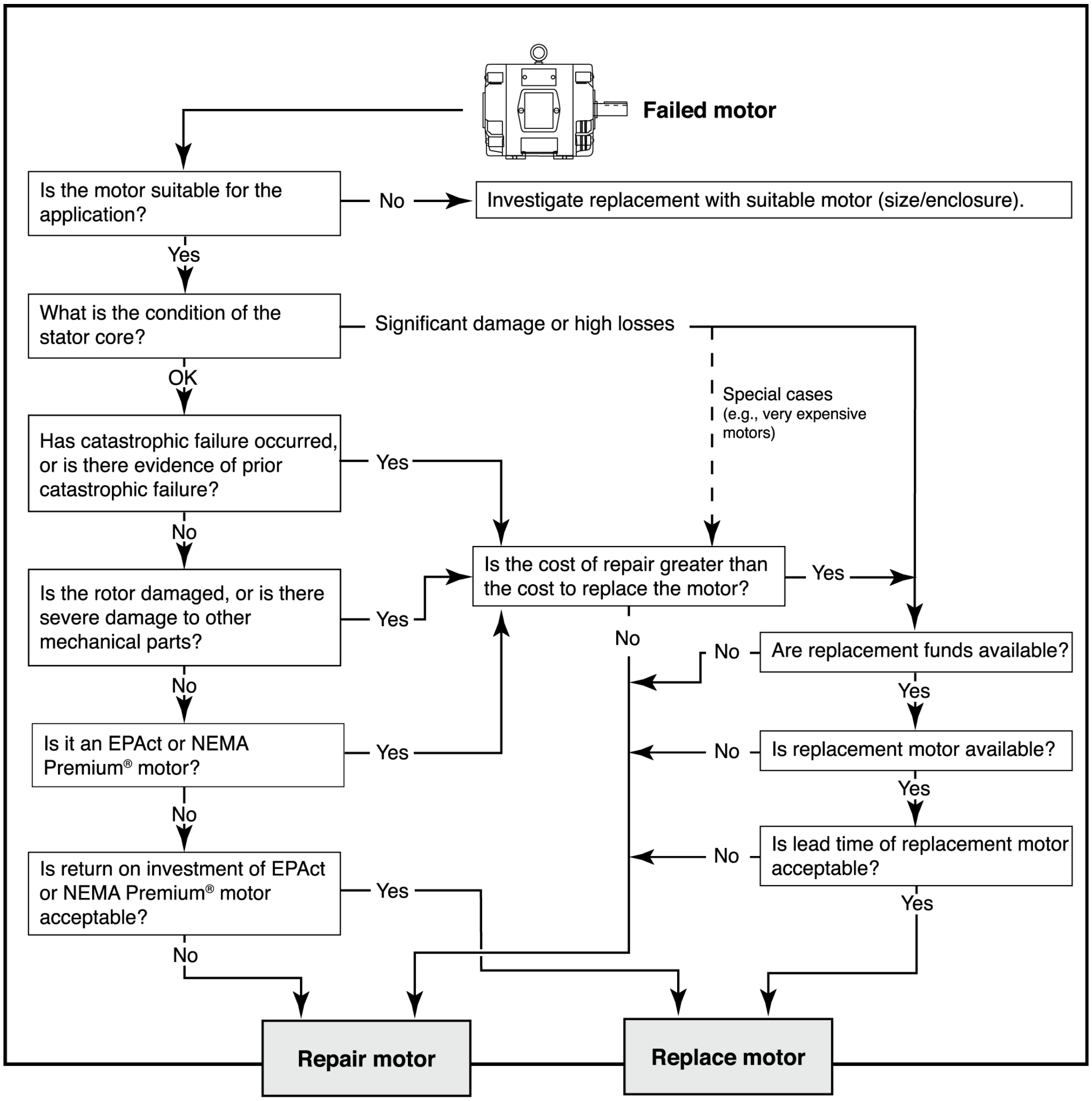
- If the motor is not suitable for that application, then the motor should be REPLACED.
- If the motor is suitable to the application, proceed to Step 2.

Step 2 – Physical Inspection of the Damage

If the motor suits the application, look closely at the motor and examine the following:

- Is the current failure catastrophic?
- Is there evidence of a prior catastrophic failure?
- Is the stator core damaged?
- Is the rotor damaged?
- Are other mechanical parts severely damaged?

In these cases, attempt to determine the root cause of any damage to prevent it from recurring.



• Additional considerations include increased reliability, life expectancy and benefits of additional features, upgrades or modifications.

Figure 2 – Block Diagram for Motor Diagnosis (Source: EASA)

Catastrophic Failure

A catastrophic failure usually causes significant damage to the stator core, windings, rotor, bearings, etc. Users must evaluate the cost of repair, but replacement may be the best option. This is especially true for motors that are no longer ideal for an application. If the repair of the motor does not make economic sense, the motor should be REPLACED.

Previous Catastrophic Failure

After disassembling the motor, there could be evidence that the motor has failed before. Signs could be damage laminations, a damaged rotor core, bends in a shaft, end ring damage, or rotor bar damage. If there is evidence of prior catastrophic failure, consider the cost of repair. If the cost of repair is too great, then the motor should be REPLACED.

Stator Core Damage

Assess the stator core and look for visible damage. Higher than normal operating temperatures due to higher core losses can be an early warning sign of stator core failure. Repairing a damage stator core is often expensive. Unless a motor has a special function or a replacement is unavailable, it is probably more economically viable to REPLACE.

Rotor Damage

There are several major types of rotor damage that need to be evaluated.

- Contact with the stator will cause surface wear and appear as a smearing on the rotor – usually economical to REPAIR
- On die-cast designs, end bars and rings can melt – usually economical to REPLACE
- On fabricated designs, broken bars or bar-to-end ring joints – usually economical to REPLACE

Other Mechanical Damage

Finally, look over the rest of the motor's frame, shaft, and other mechanical components for damage that is beyond repair. Determine the cost of repairs or replacing any damaged components versus replacing the entire motor.

REWINDING

Overview

For a thorough understanding of the rewinding process see ANSI/EASA AR100-2015: Recommended Practice for the Repair of Rotating Electrical Apparatus.[1] Rewinding is often a cost-effective way to repair a motor and maintain efficiency. Service centers that follow good practices provide repairs with a proven record of maintaining motor efficiency.

Another useful resource is The Effect of Repair/Rewinding on Motor Efficiency: EASA/AEMT Rewind Study and Good Practice Guide to Maintain Motor Efficiency.[2]

Repair practices for EPAct (IE2) or NEMA Premium® (IE3) motors are the same.

Recommendations

To ensure the best possible outcome when a motor is rewound, it is important to consider the following:

- Ensure the overall length of turns in winding does not increase
  - More resistance increases loss
- Increase wire area when slot fit allows it
  - Lower resistance reduces losses

These steps maintain or reduce winding copper (I^2R) losses:

- Reduced losses => increased efficiency

With these recommendations in mind, here is an overview of steps for the rewinding process:

1. Perform core testing before and after winding removal and repair/replace the core if needed.
2. To maintain efficiency:
   a. Use the same winding pattern, or if possible, the pattern can be improved (concentric to lap for example)
   b. Use the same or greater winding coil wire area
   c. Use the same or shorter average length of turns
3. To increase efficiency:
   a. Increase slot fill (Figure 3)
      i. Reduces heating
   b. Use larger winding coil wire area (Figure 4)
      i. Reduces I^2R losses
4. Measure and compare winging resistance
5. Run test motor
   a. Check operating speed
   b. Measure no load current and compare to full load rating

Figure 3 – Increased Slot Fill. (Source: EASA)

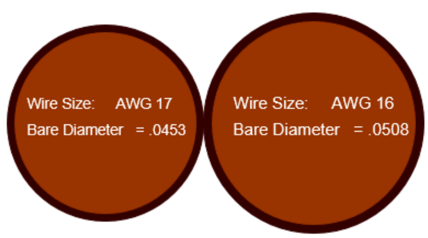


Figure 4 – Larger Wing Wire. (Source: EASA)

REPLACING A MOTOR

There are many questions to consider when replacing a motor.

1. What is the complete nameplate information from the existing motor?
2. What is the driven equipment?
   a. Does motor drive a fan, blower, conveyor, pump, etc.?
3. How does the motor connect to the load?
   a. Typically, it will be either directly coupled or belted.
4. Is there any other equipment attached to the motor?
   a. Examples: clutches, gearboxes, and brakes
5. What is the motor's history?
   a. A "problem application" with repeat failures?
   b. Nature of the failures?
   c. How long did the motor operate before each failure?
6. How is the motor started?
   a. Across the line
   b. Autotransformer reduced voltage
   c. Electronic soft start
   d. VFD (variable frequency drive)
   e. Part-winding start
   f. Wye-start – delta-run
7. What is the operating environment?
   a. Indoors vs. outdoors
   b. Hazardous fumes, dusts, or water spray
   c. High or low ambient temperature
8. How soon is the new motor needed for operation?
   a. The right motor is not useful if it is not ready when needed.
9. Can the motor be replaced with a NEMA Premium® motor?

CONTACT INFORMATION

For more information contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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1 https://www.easa.com/sites/files/resource_library_public/EASA_AR100-2015_0815_0.pdf

2 https://www.easa.com/sites/files/resource_library_public/EASA_AEMT_RewindStudy_1203-0115.pdf

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