Electric Motors: Repair or Replace?

Presented by:

GODING ELECTRIC COMPANY

Electric Motors and Controls ... since 1922

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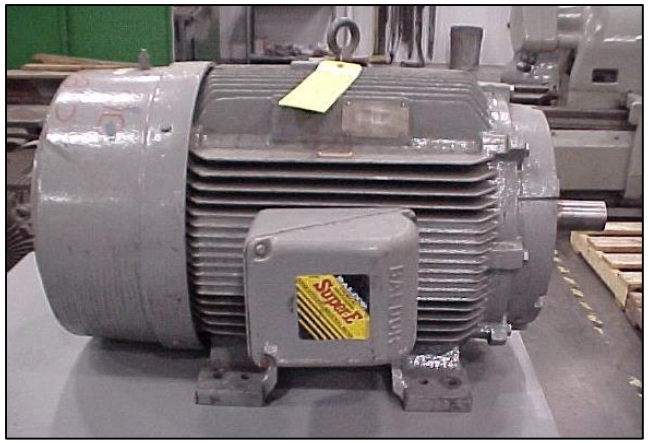
Introduction

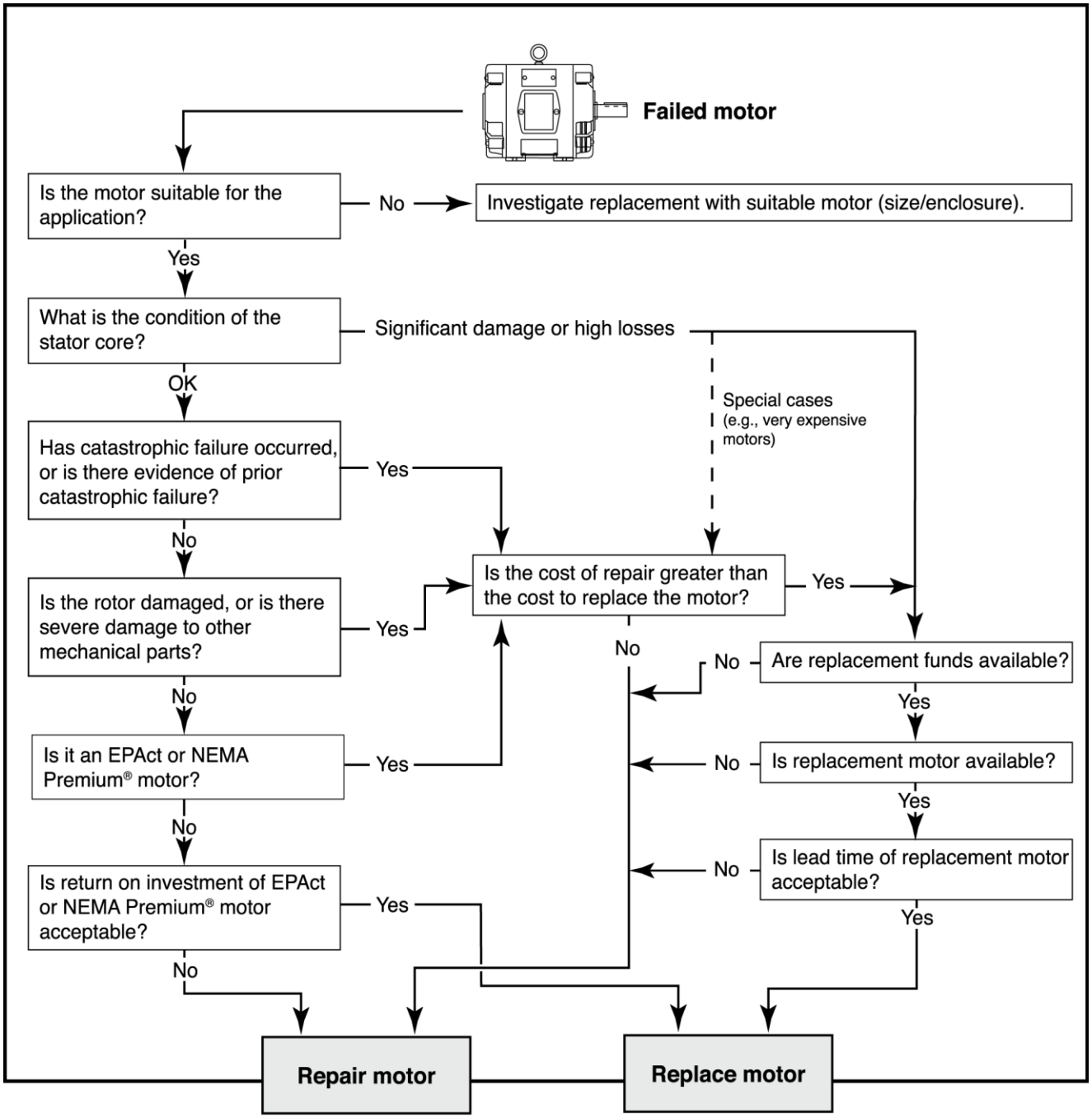
- Perennial plant maintenance questions:
  - Is it better to repair or replace an electric motor that has failed?
  - Will a repaired motor retain its efficiency?



- We will answer the above, and provide:
  - Better understanding of key criteria to consider when facing this decision
  - Details about EASA Accreditation Program for electric motor repair

Repair/replace decision-making process

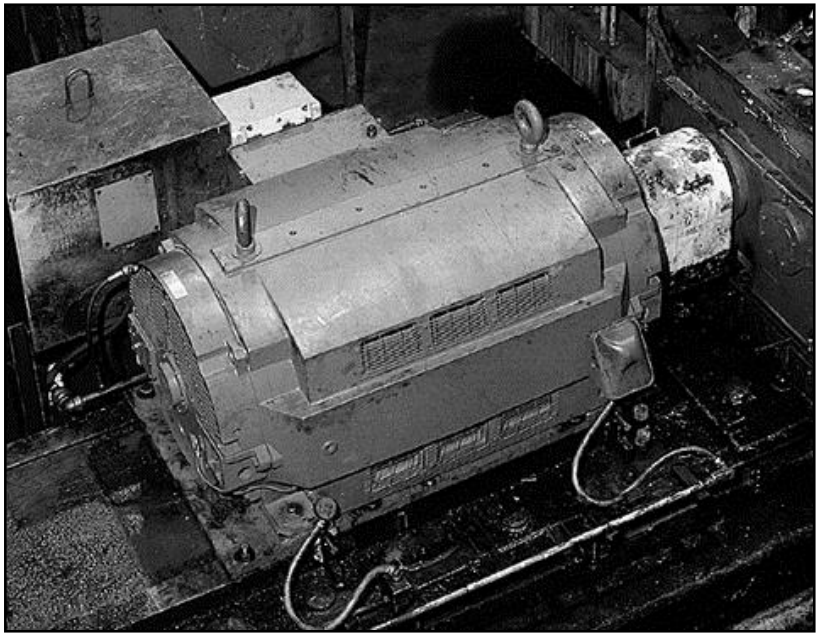
- Well-informed decisions involve many criteria
  - Suitability for application
  - Condition of stator core
  - Condition of rotor
  - Efficiency rating; lifecycle costing
  - Availability of funds and replacement motor
  - If it's not an EPAct (IEC IE2) or NEMA Premium (IEC IE3), is ROI of replacement acceptable?
- Flowchart on next slide provides overview of process
- Specific applications may add other unique characteristics



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

Review application

Suitable for application?



Example

Open enclosure may not be practical for paper mill

- Airborne moisture & debris
- Better choice:
  Totally-enclosed, fan-cooled (TEFC) replacement with the addition of:
  - Weep/drain holes
  - Space heaters

Review application

- Reassess application as part of repair/replace decision
  - Processes and duty cycles can change over time
- Even better approach:
  - Assess all critical applications prior to failure as part of a motor management plan

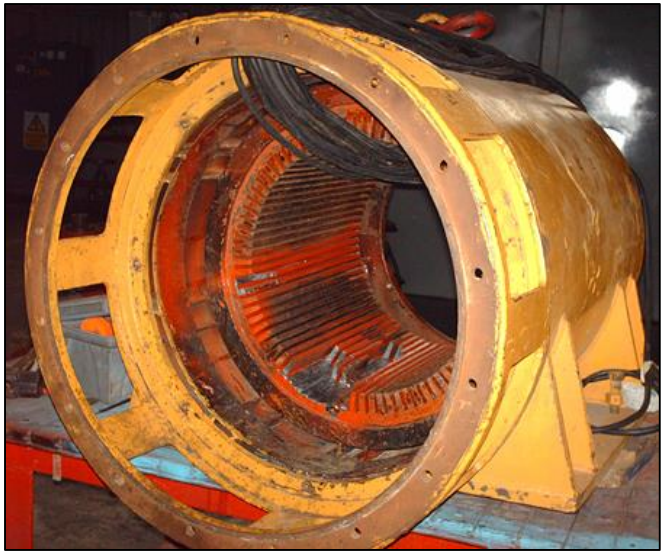
Multiple decision points

Consider these decision points simultaneously:

- Is the present failure catastrophic?
- Is there evidence of a prior catastrophic failure?
- Is the rotor damaged?
- Are other mechanical parts severely damaged?
- Is it an EPAct (IE2) or NEMA Premium® (IE3) motor?

Catastrophic failure — present

- Evaluate cost of repair vs. replacement
- Catastrophic failures typically do considerable damage to:
  - Stator core
  - Windings
  - Other motor parts including:
    - Rotor
    - Shaft and bearings
    - End brackets

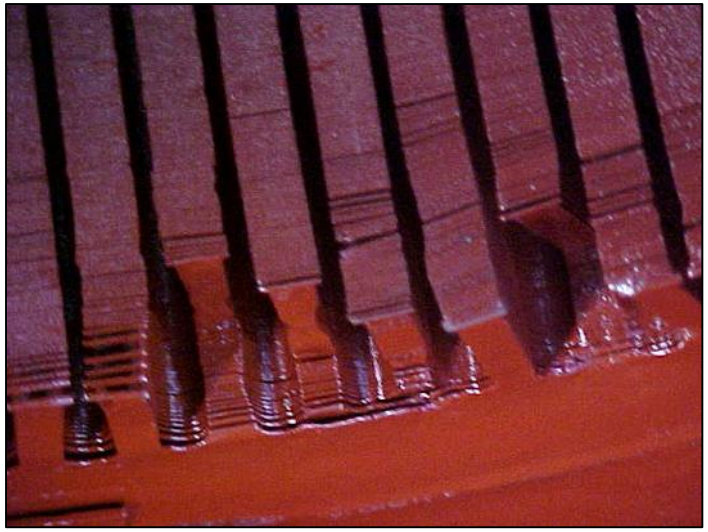


- Replacement may be most economical option (especially if suitability for application is questionable)

Catastrophic failure — prior

Evidence of prior catastrophic failure may be apparent only after motor disassembly, e.g.:

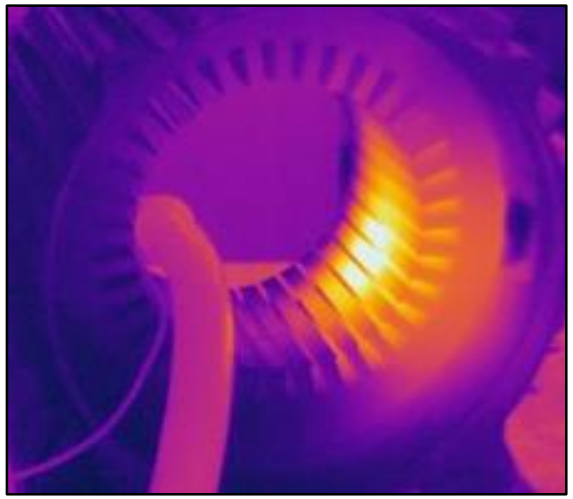
- Damaged stator core laminations
- Damaged rotor core
- Damaged rotor bars or end rings
- Bent shaft that has bent again



Stator core condition

If failed motor suits application:

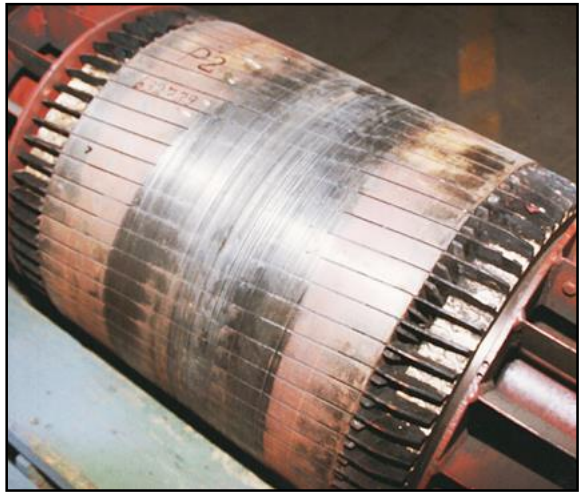
- Assess condition of its stator core
  - Is damage significant?
  - Did motor exceed rated temperature rise before it failed (e.g., due to high core losses)?
- If core damage is significant, may be more economical to buy new motor
  - Repair of seriously degraded stator core can be expensive
  - Unless motor has special features affecting replacement price or availability



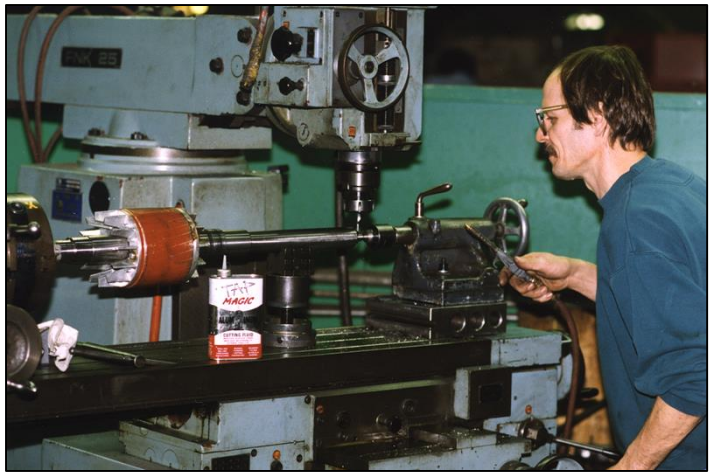
Rotor condition

If failed motor suits application:

- Assess condition of rotor
  - Is damage significant?
  - Did motor exceed its rated temperature rise before it failed (e.g., due to high core losses)?
- If rotor damage is significant, may be more economical to buy new motor
  - Repair of seriously degraded rotor can be expensive
  - Unless motor has special features affecting replacement price or availability



Mechanical parts condition

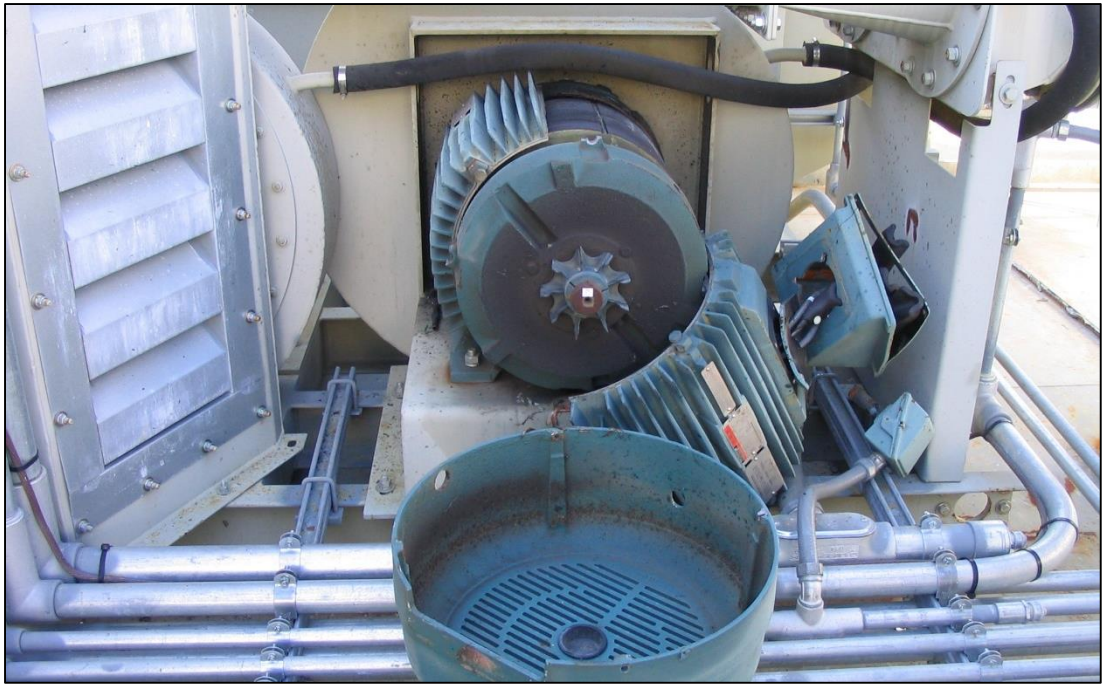


Shaft, frame, bearing housing or other mechanical parts may be damaged beyond repair

- Making new shaft may be economical option
- Cost of buying new may make replacing motor the logical choice (unless motor is very large or has special features)

Root cause failure analysis

- Identify and address underlying causes of failure to prevent recurrence(s)
- Applies to both repair and replace



EPAct (IE2) or NEMA Premium® (IE3) motor

Transition in repair/replace decision process

- Factors to this point have shaped process for over a half-century
- Whether to replace a failed motor with a more energy-efficient model is an important consideration

EPAct (IE2) or NEMA Premium® (IE3) motor

Higher efficiency motors:

- Those covered by earlier U.S. federal regulations (EPAct 1992) — equivalent to IEC motors labeled IE2
- NEMA Premium® motors covered by newer U.S. federal regulations (EISA 2007) — equivalent to IEC motors labeled IE3

EPAct (IE2) or NEMA Premium® (IE3) motor

Repair considerations for higher efficiency motors

- Same as for older standard efficiency models
- Efficiency and reliability can be maintained by qualified service centers that
  - Follow good practices of *ANSI/EASA AR100* and *EASA/AEMT Rewind Study*
  - Participate in EASA Accreditation Program

EASA ACCREDITED MEMBER

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EASA AR100

Company Name
City, State/Province

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EPAct (IE2) or NEMA Premium® (IE3) motor ROI

Consider return on investment (ROI) of a higher efficiency replacement before having a lower efficiency motor repaired

- Examples
  - NEMA Premium® (IE3) in place of EPAct (IE2) motor
  - EPAct (IE2) in place of older standard efficiency motor
- Factors
  - Expected life of motor or process
  - Hours of operation
  - Energy costs
- Verify that replacement is higher efficiency than motor being replaced

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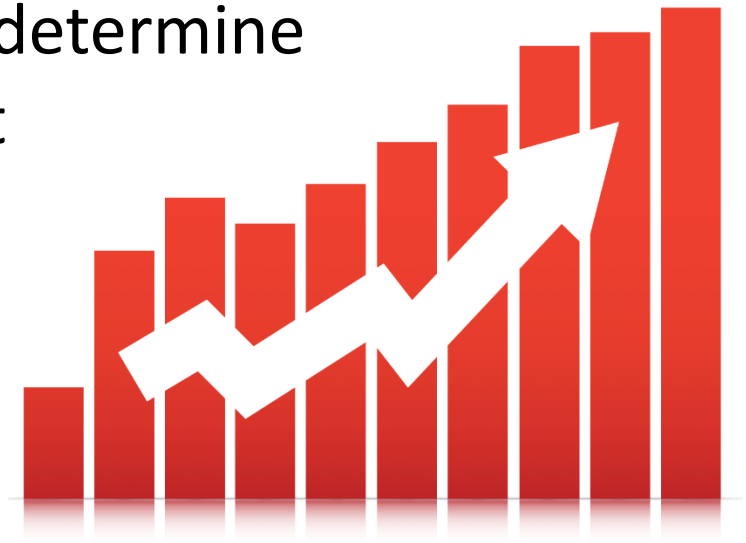
EPAct (IE2) or NEMA Premium® (IE3) motor ROI

- If analysis favors replacement, determine whether cost fits within budget
- If not, best option may be good practice repair (if it costs less than a new motor)



Next decision: Motor availability

- Motors such as those under EISA rules are usually stock items
- Larger motors or those with special features often have delivery times up to several months

Next decision: Motor availability

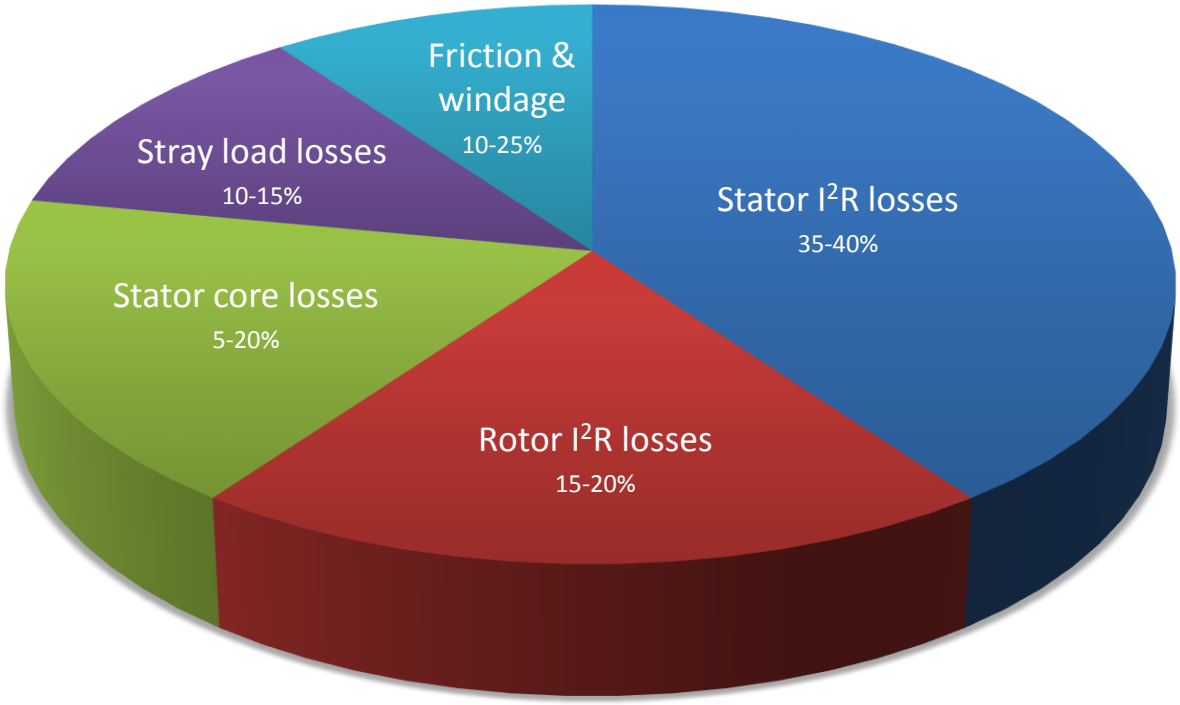
If delivery time exceeds your requirements:

- Qualified service center usually can provide a good practice repair of original motor in far less time
- Service center may be able to add special features to a stock higher efficiency motor, e.g.:
  - Convert it to a C-face or D-flange mounting
  - Modify the output shaft

Motor efficiency

Manufacturers improve motor efficiency by reducing losses, primarily through design changes

Breakdown of motor losses



Motor efficiency

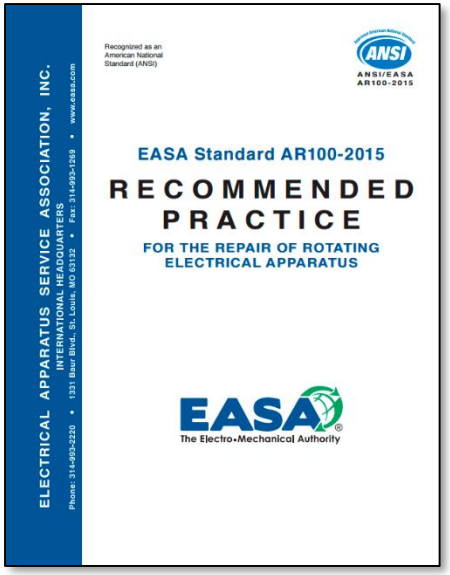
Ways manufacturers improve efficiency

- Some high efficiency models have longer stator and rotor cores (reduces core losses)
- Some have more copper wire area in windings (reduces copper losses)
- Fans of totally enclosed, fan-cooled (TEFC) designs
  - Use smallest fan that keeps winding within design temperature limit
  - Minimizes power diverted to windage

Repaired motor efficiency

Service centers that follow good practices provide repairs with a proven record of maintaining the efficiency of standard and higher efficiency motors

- Good practices found in *ANSI/EASA AR100 Recommended Practice for the Repair of Rotating Electrical Apparatus*
- And more specific recommendations in *EASA/AEMT Rewind Study's* "Good Practice Guide"
- Download both free at www.easa.com/energy

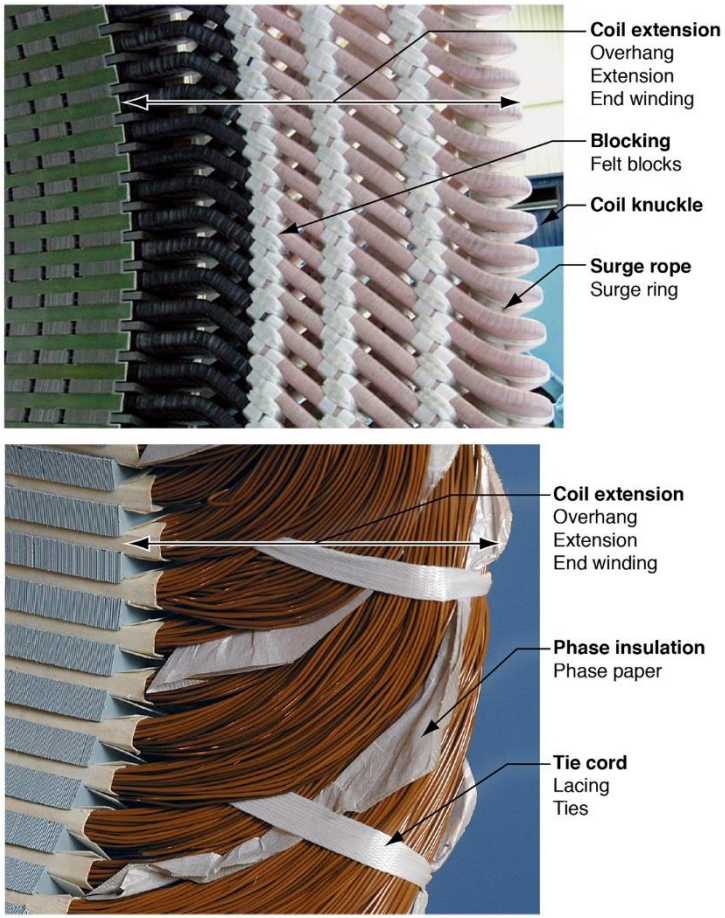


Repaired motor efficiency

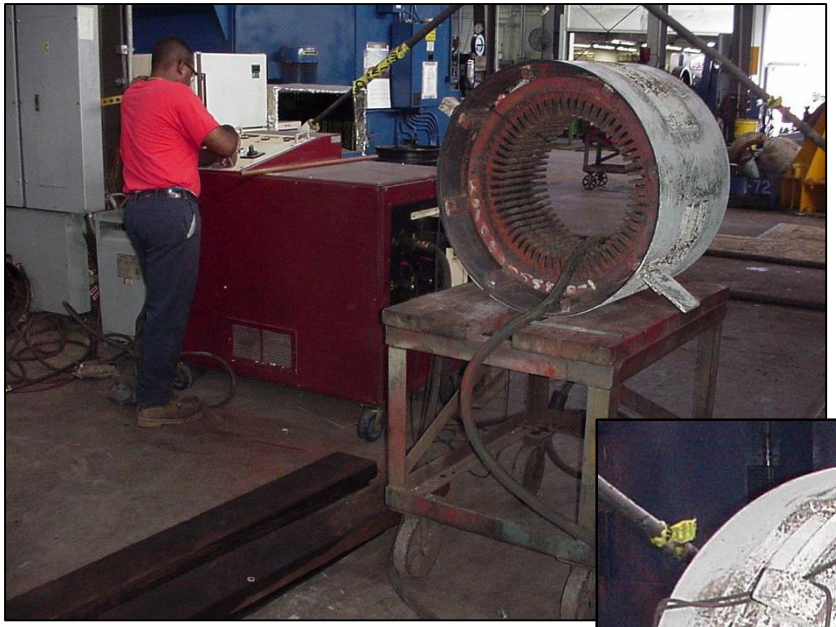
Among good repair practices identified by the two documents are:

- Ensuring that overall length of turns in winding does not increase (more resistance increases loss)
- Increasing wire area when slot fit allows it (lower resistance reduces losses)

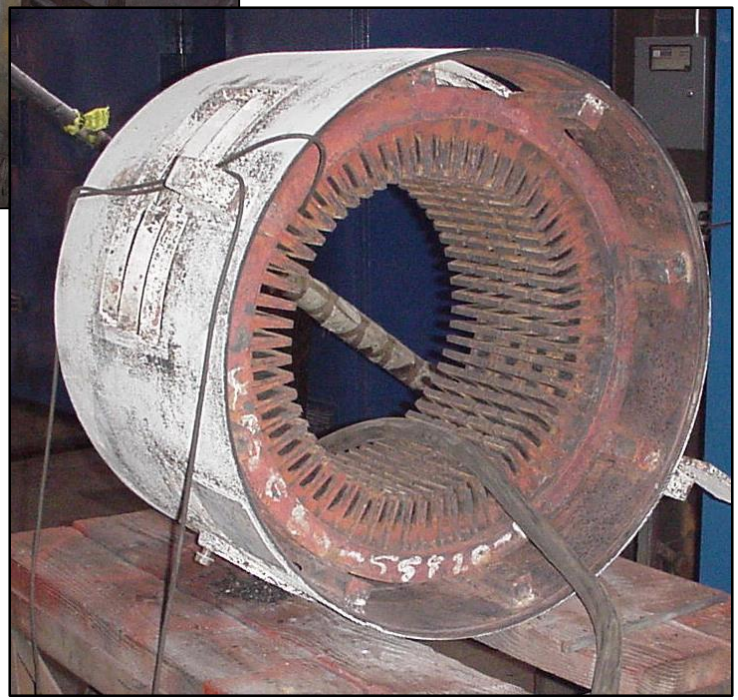
Steps above maintain or may reduce winding copper (I^2R) losses



Rewinding good practices



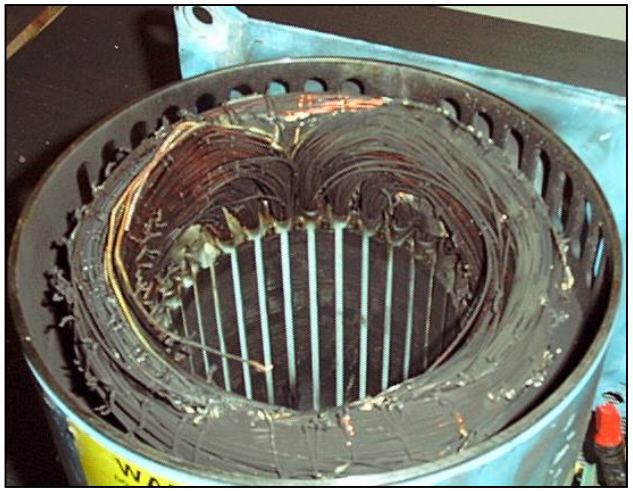
- Test for core losses before and after winding removal
- Repair or replace a defective core

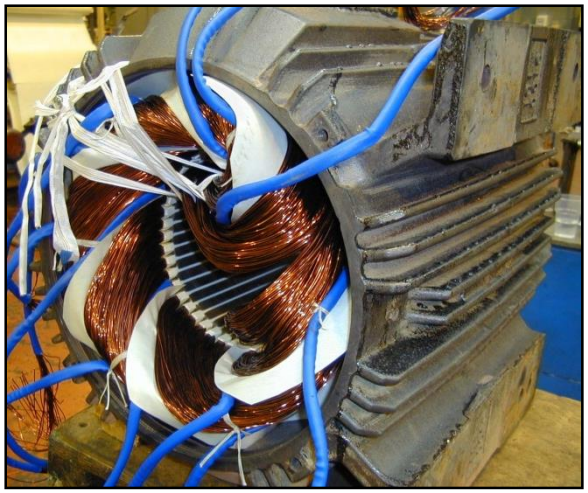


Rewinding good practices

Maintain efficiency by:

- Copy-rewinding or improving winding pattern (e.g., concentric to lap)
- Using same or shorter average length of turns

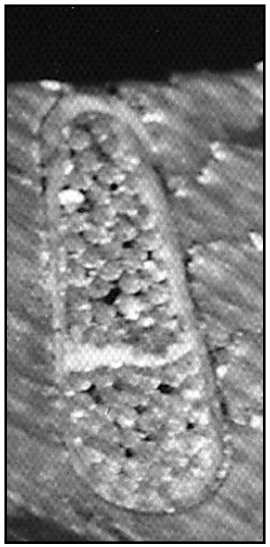




Rewinding good practices

Opportunity to improve efficiency by:

- Increasing slot fill (reduces heating)
- Using larger winding coil wire area (reduces I^2R losses)



Wire Size: AWG 17
Bare Dia. = .0453

Wire Size: AWG 16
Bare Dia. = .0508

Testing good practices

- Measure and compare winding resistance lead to lead
- No-load testing
  - Check exact operating speed
  - Measure no-load current and compare to full-load rating

EASA Accreditation Program

International program for electrical apparatus service centers

- Based on electric motor repair good practices
  - ANSI/EASA AR100 *Recommended Practice for the Repair of Rotating Electrical Apparatus*
  - "Good Practice Guide" of 2003 study, *The Effect of Repair/Rewinding on Motor Efficiency*
- EASA membership not required

Accreditation program overview

Independent auditors evaluate service centers for compliance

- Assure use of prescribed good practices to maintain motor efficiency and reliability
- Repair processes assessed include:
  - Instrument calibration
  - Mechanical measurements
  - Core testing and rewinding
  - Bearing replacement/lubrication
  - Bearing fit rebuilding
  - Electrical testing

Accreditation program overview

EASA Accreditation Audit Checklist (Version 2.0)

Conformance to recommended practices and guidelines

Recommended Practice: ANSI/EASA AR100-2015 [AR100]
Guideline: Good Practice Guide to Maintain Motor Efficiency [GPG]

1. Identification and condition assessment

	Score	Audit Category	Checklist item
Criteria		MA	Original nameplate data of repaired motors is documented; or document if nameplate is not present or illegible.
		MI	Shop order number is permanently marked on motors received for repair.
		MA	Records of each shop order are established and retained for at least 3 years after repair.
		MI	The primary cause of failure is determined, if possible, and documented in the repair record.
		MA	Job records document findings during incoming inspections, such as physical condition, mechanical damage, and evidence of overheating; and customer's reason for repair.
Equipment	Ø	Ø	N/A
Source references: AR100-1.3-1.5; GPG 1, 2.7-2.8			

Comments:

2. Terminal leads, connectors and boxes

	Score	Audit Category	Checklist item
Criteria		MI	Terminal leads of completed repairs are labeled.
		MA	Terminal lugs, if so equipped, are properly crimped.
		MI	Size and type of replacement lead wire are documented.
		MI	Terminal box integrity (e.g., not damaged) is checked.
Equipment	Ø	Ø	Confirm calibration and functionality of associated equipment.
		MA	Terminal crimpers function checked at least quarterly for wear and proper crimp by service center
Source references: AR100-1.6-1.8; GPG 2.1			

Comments:

4

Conformance verified by objective third-party audits

- Independent external audits every 3 years
- Supplemented with mandatory internal self-audits
- 70+ criteria checklist used to assess conformity

Accreditation program overview

Three-phase electric motors that conform to repair requirements are labeled by service center with EASA-approved sticker

Accreditation program motor labels

Questions?

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