



Motor Shop Selection & Evaluation Guide



Low and Medium Voltage Motor Repair

Why do we repair electric motors? To realize the benefit of added running hours without incurring the higher expense of a new motor. How much added life we get is very dependent on the quality and accuracy of the repair. A quality audit of your repair vendor is an invaluable activity to ensure that you get the most for your money. Without an audit, it is very difficult to assess what you are getting for your investment. Even poor repairs usually last a few years — beyond most warranties.

The audit form that follows has been prepared from both experience and examination of industry accepted audits. It is designed for a typical motor services buyer expecting a quality repair. Much more robust audit forms are available and recommended where larger and more complex machines are concerned. Your repair specification will often dictate the degree of specificity required in your audit.

The audit form is presented in a way that even inexperienced buyers could feasibly conduct the audit, which in itself is a very educational activity. It is also a great way to enhance the relationship with your service providers.

There are 14 identified fail points that can be quickly assessed. Here is a common one.



A repair report says a lot about the quality of a given shop, if you know where to look.

Sample Report

Balancing Results	ISO Balance	G2.5		
	Rotator Weight	185 lbs		
	Unbalance Llimit	0.08 oz/in		
	Test Speed	600 rpm		
	Drive End	1.99 oz/in		
	Opposite End	1.57 oz/in		
Load Test Results	HP			
	Amperage (Full Load)			
	Torque RPM			
Core Loss Test w/ lbs	Burnoff (Before-After)	4.50		
	Test Voltage	1000		
Insulation Resistance Results		MΩ	@ Temp °C	Corrected
	Stator	0	40	0.0
	Rotator	N/A	40	0.0

Getting started

The form provided should serve as a guide through a complete audit. Scoring suggestions are offered to aid in comparison between shops. Fail points denote a common problem in aging shops where quality often suffers from lack of knowledge. Noted fail points are in areas having a significant impact on run life, and suggest that immediate remediation is necessary.

Don't have time for a complete audit?

Review the suggested fail points instead. These are easily assessed items that can provide for a quick indication. A fail point denotes a serious problem that the vendor should address before any additional activity occurs.

Don't have time to visit your shops?

Conduct a repair report audit instead. A repair report can tell you a lot about a repair vendor. The presence of certain data points can denote the use of specific procedures. The absence of those points can denote a problem. This is a very efficient way to quickly screen a repair vendor.

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Fail point results:
A single fail point indicates an overall failure and should raise question.

Suggested Guidelines

Motor repair vendor audit	
1) Minimum audit:	Repair report audit
2) Minimum onsite audit:	Fail point audit
<p>Standard audit progression: Proceed through each step defined. You may consider quickly stepping through fail points as an immediate filter. A fail point indicates a fundamental problem that should disqualify the vendor immediately until resolved.</p>	<ol style="list-style-type: none"> 1. Repair Report 2. Quality Program 3. Critical Process and Repair Practice 4. Energy Efficient Practices 5. Warranty and Safety

Scoring Reference

Date:	Vendor:	Conducted by:
Repair report results:	Fail point results:	Complete audit score:

A perfect repair report score is 25. Fail point score is 40. Complete audit score is 120.

Basic - Repair Report Audit

Fail Point	Audit Point	Score (0-5)	Guideline	What to look for:
Fail Point	Name plate data		0 - Missing data 5 - Complete data	Name plate data, including horsepower, voltage, RPM, motor type, and serial number.
Fail Point	Warranty Confirmation		0 - Missing data 5 - Complete data	Repair date and job number (for warranty management)
Fail Point	Evidence of appropriate balance methods		0 - Missing data 5 - Complete data	Rotor weight (lbs) and imbalance (oz-in). This denotes ISO balancing. Vibration measurements alone denote NEMA balancing, which is not compliant with EASA.
Fail Point	Evidence of appropriate insulation test methods		0 - Missing data 5 - Complete data	Insulation reading in ohms, temperature compensated reading in ohms, ambient temperature. Temperature compensation is mandatory to a meaningful reading.
Fail Point	Evidence of appropriate insulation test methods		0 - Missing data 5 - Complete data	Critical when reviewing a post repair incident or warranty. There should be nine fits per journal, which will detect an egg shape.

Motor Repair Vendor Audit

1.0 Is there an established and managed Quality Program?

Fail Point	Audit Point	Score (0-5)	Guideline	What to look for:
	Is there a designated quality manager? Is this person empowered to stop operations?		0 - No designated personnel 3 - Designated but not empowered 5 - Designated and empowered	Look for a role designated outside of normal operations. This role(s) should be empowered to stop operations on quality hold points.
Fail Point	Documented evidence of internal audits of quality by inspecting personnel?		0 - No evidence 3 - Dated evidence with relevance 5 - Current evidence with specific relevance	An audit should specify areas of inspection, results, and noted issues.
	Documentation samples of corrective action process.		0 - No evidence 3 - Dated evidence with relevance 5 - Current evidence with specific relevance	
	Does the corrective action process address rework?		0 - No evidence 3 - Dated evidence with relevance 5 - Current evidence with specific relevance	
Fail Point	Request written procedures, from actual technicians, for: 1. Insulation Resistance Testing 2. Rotor Balancing 3. Bearing and journal inspection 4. Bearing Installation 5. Vibration Acceptance Testing		Provide one point for each	Procedures should be written for employee use and easily accessible by employees. Thus it is important to request that a working technician(s) provide them if possible
	Documented calibration program		0 - No evidence 5 - Fully defined program	The calibration program should be current, within the last year, and have five years of history. Records should include specific items to be calibrated, the calibration service provider, and the interval. Specialty items, such as balancing machines and core loss testers should have specific calibration providers.
Fail Point	Evidence of calibration within 12 months on:		0 - Missing calibration 5 - All items selected show calibration	Record of a recent calibration of each of the selected items.
	1. Selected handheld meters 2. Burnout oven temperature loops 3. Test panel meters 4. Micrometers and gauges			

1.0 Is there an established and managed Quality Program? (Continued)

Fail Point	Audit Point	Score (0-5)	Guideline	What to look for:
Fail Point	Documentation of Dip Tank and VPI tank samples evaluated by a credible lab at no more than 60 day intervals (request a history)		0 - No evidence 5 - Fully defined	Records of results from a credible lab (i.e. manufacturer). Ask about any corrective action.
Fail Point	Documentation samples of corrective action process.		0 - No evidence 5 - Fully defined	Easily visible aids defining levels for surge and overvoltage testing by application.
	Visual aids providing support and direction		0 - Minimal aids 5 - Clear aids for PPI, process, test levels, etc.	Large banners or aids to guide personnel, especially new employees.

2.0 Are critical processes and repair practices accurately observed?

Fail Point	Audit Point	Score (0-5)	Guideline	What to look for:
Fail Point	Insulation Resistance Testing (meg)		0 - No temperature compensation. 5 - Reading is compensated for temperature.	Request a demonstration of an insulation resistance test (meg ohm). Look for a temperature reading to be taken and for the meg ohm reading to be compensated for temperature.
Fail Point	Rotor Balancing		0 - No temperature compensation. 5 - ISO calibration is visible and rotors are being weighed	Is there an ISO calibration and machine certification visible? This is a requirement of ISO 1940. Key point, are rotors being weighed and is that weight recorded?
	Request demonstration of how bearing journals are measured		0 - Inside micrometers are used. 5 - Bore gauges are used and multiple measurements are recorded	Look for bore gauges and do not accept inside micrometers. Readings should be taken at multiple places (9 or more) to catch egg shaped journals.
	Bearing Installation		0 - No evidence of temp control 5 - Heater used has digital readout and an auto shut off function	Examine the bearing heater. Is the heater calibrated, is there an auto shutoff to avoid overheating? An SKF heater with digital readout is a good sign.
	Vibration Acceptance Testing		0 - No evidence 3 - Overall limits taken 5 - Full spectrum conducted with defined band limits	Ask if readings are taken, and look for pass/fail criteria. Where was the criteria taken from?
	When is a core loss test conducted?		0 - After burnout 5 - Before and after burnout	Testing should be conducted and recorded before burnout of the stator and after stripping. This is to ensure the stator iron was not compromised during the process. The use of thermal cameras to detect hot spots is highly encouraged.
	What are the standards for materials and construction of form wound windings?		0 - No evidence 5 - Fully defined	Coil insulating standards should be defined in writing and by voltage level.
	What steps are taken to isolate lubricants from potential contaminants?		0 - No evidence 3 - Partial evidence 5 - Compliant	Grease guns should be labeled and capped off. Oil containers should be clearly identified. Grinding, cleaning, and machine operations should not be performed in assembly areas.

3.0 Safety and Warranty Management

Fail Point	Audit Point	Score (0-5)	Guideline	What to look for:
Fail Point	Are the PPE requirements described in procedure or policy? Provide evidence of documentation.		0 - No evidence 5 - Fully defined program	A guideline for use of safety glasses, gloves, shields, and other personal protective equipment (PPE).
	Are chemical hazards identified? If so is program documented?		0 - No evidence 5 - Fully defined program	Identification of chemical hazards in tanks, solvents, and other applications.
	Is the proper use of PPE displayed by shop personnel?		0 - No personnel utilizing PPE 3 - Limited personnel utilizing PPE 5 - All personnel utilizing PPE	
	Is there a defined warranty policy?		0 - No evidence 3 - Limited warranty program with no documentation 5 - Fully documented warranty program	Ask to see the warranty policy.
	How are warranty claims evaluated, and by whom?		0 - No evidence 3 - Limited warranty program with minimal documentation and no assigned technician/department. 5 - Fully documented warranty policy with assigned technician/department.	Warranties should not be evaluated by operations personnel charged with repair. There should also be a define goal to limit warranties, measured as a percent of total sales..5% is used by leading shops.

Are required standards available?

Governing standards should be on hand to denote a foundation of knowledge. Look for copies of all or for a randomly selected portion. **Standards highlighted in yellow are absolutely minimum and their absence would denote a significant problem.**

Required standards

(denote missing standards with an 'x')

- EASA AR-100
- EASA Technical Manual and Winding DATA
- EASA Q or similar ISO based quality program guideline
- IEEE Standard 43: IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
- IEEE Standard 95: IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
- IEEE Standard 112: IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- IEEE Standard 432: IEEE Guide for Insulation Maintenance for Rotating Electric Machinery (5 hp to less than 10 000 hp).
- IEEE Standard 522: IEEE Guide for Testing Turn-To-Turn Insulation on Form-Wound Stator Coils for Alternating-Current Rotating Electric Machines
- ISO 1940-1: Mechanical Vibration–Balance Quality Requirements of Rigid Rotors. ISO 1940-2: Determination of Permissible Residual Unbalance.
- ISO 10816-1: Mechanical Vibration–Evaluation of Machine Vibration by Measurements on Non-Rotating Parts–Part 1: General Requirements
- ISO 10012-1: Quality Assurance Requirements for Measuring Equipment.
- ANSI/ABMA Standard 7-1995: Shaft and Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) American Bearing Manufacturers Association, Inc.
- ANSI S2.41-1985: Mechanical Vibration of Large Rotating Machines with Speed Ranges From 10 to 200 RPS. Measurement and Evaluation of Vibration Severity
- ANSI/NCSL Z540-1-1994: Calibration–Calibration Laboratories and Measuring and Test Equipment - General Requirements.
- NEMA Standards MG 1-2006: Motors and Generators. National Electrical Manufacturers Association.
- NFPA Standard 70E-2009: Standard for Electrical Safety in the Workplace. National Fire Protection Association
- 29CFR1910.331 - .335 OSHA: Electrical Safety-Related Work Practices. Occupational Safety and Health Administration.

Desirable and application specific standards

(denote missing standards with an 'x')

- UL 674 Rebuilding Explosion Proof Motors
- IEEE Standard 1068: IEEE Recommended Practice for the Repair and Rewinding of Motors for the Petroleum and Chemical Industry.
- IEEE Standard 115: IEEE Guide: Test Procedures for Synchronous Machines.
- IEEE Standard 792: IEEE Recommended Practice for the Evaluation of the Impulse Voltage Capability of Insulation Systems for AC Electric Machinery Employing Form-Wound Stator Coils.
- IEC Standard Publication 60034-8: Rotating Electrical Machines, Part 8: Terminal Markings and Direction of Rotation of Rotating Machines.
- IEC Standard Publication 60072-1: Part 1–Frame Numbers 56 to 400 and Flange Numbers 55 to 1080.
- IEC Standard Publication 60136: Dimensions of Brushes and Brush-holders for Electric Machinery