Low and Medium Voltage Motor Repair

Service Center (Shop) Selection and Evaluation Guide

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 you get the most for your money. It is otherwise very difficult to assess what you are getting for your investment without one, as even poor repairs will usually last a few years – and beyond most warranties.

The audit form shown below has been prepared from both experience and examination of other industry accepted audits. It is not the most stringent, as it is rather designed for the typical motor services buyer expecting a quality repair. Much more robust versions are available, especially when larger and more complex machines are concerned. Your repair specification will often dictate the degree of specificity required in your audit.

The format 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.

Electrical Equipment Company, Feb 2014

Getting started

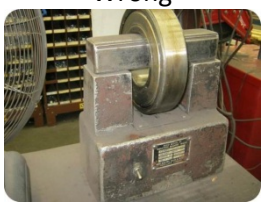
The form provided should serve as a guide through a complete audit. Scoring suggestions are offered to aid in comparison between shops. Fail points denote a common problem in aging shops where quality often suffers from lack of knowledge. Noted fail points are in areas having a significant impact on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

Don't have time for a complete audit?

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

There are 14 identified fail points that can be quickly assessed.

Wrong



Right

Don't have time to visit your shops?

Conduct a repair report audit. That's right – 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.

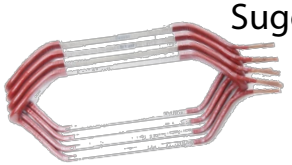
A repair report says a lot about the quality of a given shop, if you know where to look.

Balancing Results	**ISO Balance**		**G2.5**	
	Rotor Weight		**185**	**lbs**
	Unbalance Limit		**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**	
Insulation Resistance Results	**Test Voltage**		**1000**	
		MΩ	@ Temp °C	Corrected
	Stator	**0**	**40**	**0.0**
	Rotor	**N/A**	**40**	**0.0**

If you need help, or would like to develop a specification, contact us at 800.993.3326. We are always happy to assist.

EECO

Motor repair vendor audit



Suggested Guidelines

1) Minimum audit:	Repair report audit
2) Minimum onsite audit:	Fail point audit
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.*	1. Repair Report 2. Quality Program 3. Critical Process and Repair Practice 4. Energy Efficient Practices 5. Warranty and Safety

Date:	**Vendor**	**Conducted by:**
Repair report results: *(Summation of total points scored)*	**Fail point results:** *(a single fail point indicates an overall failure and should raise question)*	**Complete audit score:** *(Summation of total points scored)*

Basic – Repair Report Audit

Quick Audit Fail Points	Audit Point	Score (0-5)	Guideline	What to look for:
Fail Point	Name plate data		0 – Missing data 5 – Complete data	Nameplate 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	Before and after bearing fits		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.

1.0 Is there an established and managed Quality Program?				
Quick Audit Fail Points	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 (meg) 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, with 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.**

1.0 Is there an established and managed Quality Program?				
Quick Audit Fail Points	Audit Point	Score (0-5)	Guideline	What to look for:
	1. Selected handheld meters 2. Burnout oven temperature loops 3. Test panel meters 4. Micrometers and gauges			
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 (ie manufacturer). Ask about any corrective action.
Fail Point	Documented electrical testing levels by application and motor voltage level.		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?				
Quick Audit Fail Points	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	Examine the bearing heater. Is the heater calibrated, is there an auto shutoff to

2.0 Are critical processes and repair practices accurately observed?				
Quick Audit Fail Points	Audit Point	Score (0-5)	Guideline	What to look for:
			and an auto shut off function	**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.**
Fail Point	**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.**

Notes:

3.0 Safety and Warranty Management				
Quick Audit Fail Points	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

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.

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Required standards *(denote missing standards with an 'x')*	
	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.

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