OFFICE OF INDUSTRIAL TECHNOLOGIES

Service Center Evaluation Guide

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ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

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Service Center Evaluation Guide

Introduction

Most users want to purchase a quality repair job, but what is quality? It is more than having the outside and inside of the motor neat and clean. Errors and careless workmanship result in reduced efficiency and shortened life of the repaired motor.

To be assured of a quality product, customers of motor repair service centers need to be knowledgeable about the service they're purchasing. It is certainly important to have a specification outlining the expected scope and quality of work. However, this cannot ensure quality work if the service center is not capable of it. **The most important thing a smart shopper can do is to carefully select a competent and reputable service center.**

There are several ways to evaluate a service center. Sending a repaired motor out for testing at a certified lab can determine efficiency and detect certain types of repairer's errors or shortcuts. This is expensive and only practical for a small sampling of motors where a large volume of business is involved. Also, it may not reveal whether a lower than nameplate efficiency resulted from the recent repair or predated it. Moreover, it cannot reveal whether one repaired motor is typical of all those from the same shop. You can gain other insights by inspecting the service center and interviewing staff. Several things can strongly suggest poor quality, while others provide reassurance. A rigorous investigation is necessary.

Obtaining Information

Several elements are indicative of a service center's ability to deliver quality work on your motors.

- **Primary market niche**
  An important starting point is to assess whether the service center does significant repair work with the type and size of motors you are likely to submit. If you expect to submit mostly small induction motors, you might want to avoid a service center whose bread and butter is locomotive MG sets. If you have many motors over 600 volts, you might want to avoid a service center that handles mostly 460 volt and under. Working a service center outside its primary market niche may adversely impact quality or price. Customers with a wide range of motor types may benefit from qualifying two or more repair service centers.

- **Tools and Facilities Inventory**
  Facilities must be in place for handling the largest motors you expect to submit. Winding heads sufficient for duplicating original winding patterns must be present. Thorough diagnostics and verification of correct repair is difficult without certain equipment like a surge tester and a well-regulated power supply.

- **Repair Materials Inventory**
  A variety of materials are used for electrical insulation in motor repair. These include slot liners, wire sleeves, special paper separators for coil groups, material for tying and restraining end turns. Most service centers stock only class F or class H insulating materials, which often exceed original insulation heat ratings. This is often touted as going the extra mile for quality. It is also cheap insurance for poor repair because it better tolerates overheating which can result from degraded efficiency. Service centers that do not have a good inventory of wire sizes in stock should be able to explain how they get restocked fast or provide stranding combinations for maintaining original wire cross-section. Imported motors may require metric wire sizes that have limited availability, but an inventory including 1/2 size AWG increments can make close approximations.

- **Staff Stability, Training, Experience, and Morale**
  A knowledgeable staff is important. A low turnover rate can be indicative of employee satisfaction, indicating management willing to invest in staff.

- **Record Keeping System**
  Good record keeping is very important. Motor management is akin to health care. A record of past problems and remedies can be invaluable for diagnosing or preventing new problems and resolving any warranty issues. An elaborate computer system may be impressive, but many service centers keep good records on job cards. These can be thorough and retained for many years.

- **Cleanliness**
  Almost intuitively, one associates cleanliness with good quality management. This is more than an aesthetic matter. Most materials and supplies used in a motor service center need to be protected from contamination. Tools and test equipment need to be organized so they can be found when needed. Gauges and testing equipment need to be put away or protected from damage when not in use to maintain calibration. Locations where bearings and lubricants are stored or installed must be clean because even very small particle contamination can be a time bomb bringing premature bearing failure.

- **Standard Operating Procedures**
  Evidence of a system for maintaining quality is important. Ideally this will include a formal quality management system involving third party inspection and certification. These are still rare, but they may become more commonplace with EASA's promotion of the EASA-Q quality management system, Advanced Energy's Proven Excellence certification program, and increasing awareness of ISO 9000 quality management standards. Service center managers should be able to point to documents that provide standards, operating procedures and important records. Examples are bearing fit standards, testing procedures, forms for record keeping, and calibration records.

Determining satisfactory adherence to quality workmanship can be time consuming. Two methods are available for evaluation: interview and inspection. Both should be used to an appropriate degree. To ensure comprehensive evaluation, an optional "**Motor Repair Service Center Checklist**" is provided at the end of this guide. It can actually be completed during the interview and annotated as necessary during the walk-through inspection. Formally completing the checklist may not be justifiable for infrequent customers of rewind services. However, it can help form a concept of equipment and practices that are important for quality repair.

Conducting the Evaluation

Make an appointment with the service center. Reserve at least half a day. Advise the service center manager that this is part of a structured evaluation and he/she may be asked to produce evidence for such things as employee training or equipment calibration practices.

The evaluator should attempt to make the service center manager feel comfortable. Allow the manager to explain answers. Do not hesitate to diverge from the written checklist to pursue a better understanding of service center practices, staff knowledge, or commitment to quality. Avoid giving the impression that you are making judgments on the spot.

It is important for the evaluator to be well informed. A familiarity with motor construction and methods and issues in motor repair are important. The interviewer should read the "*Motor Repair Tech Brief*" and he/she may benefit from more detailed sources such as the Quality Electric Motor Repair: A Guidebook for Electric Utilities.[1]

Depending upon the size of your potential business and your preferred interview style, you can consider variations in approach to the interview. Some may wish to provide the checklist to service center managers in advance of the interview. Alternately, it can be withheld if it is felt that would discourage candid responses. If it is withheld, the service center manager should be advised of the scope and general content so that he/she does not feel "blind-sided" and become uncooperative.

For your convenience a commentary regarding desirable responses is placed in the right margin of the checklist. If there is concern that the service center manager will see this and stretch for a "correct" response, it can be masked when the form is photocopied.

The first two parts of the checklist assesses service center capability. These respectively assess *capacity* capability and *specific* capability. *Capacity* pertains mainly to the size of motors that can be accommodated. *Specific* capability pertains mainly to the ability to do certain repairs that may not routinely be part of all motor rebuilds. Limitations of these capabilities do not necessarily indicate efficiency or quality problems for repair jobs not requiring those capabilities.

Motor Repair Service Center Checklist

Capacity Capability **(for multiple devices, list maximum capability of each)**

Users requiring a more detailed inventory of capability may refer to Appendix D, Quality Electric Motor Repair: A Guidebook for Electric Utilities.[1]

What is the largest motor for which the service center is fully equipped to rewind and test in-house?

Weight _____

Length _____

Diameter _____

Horsepower _____

Voltage _____

Specific Repair Capability

Check services offered:

- ❑ Random wound polyphase AC motor repair
- ❑ DC motor repair
- ❑ Single phase motor repair

Procedures, Practices, and Inventories

What primary methods of winding removal are used?

- ❑ Controlled Burn-out; typical temperature _____ °F
  (If sometimes higher, explain circumstances.)
- ❑ Chemical Stripping
- ❑ Mechanical Pulling at temperature under 400°F
- ❑ Other

How many different round wire sizes are present in inventory? _____

How many of these are "inverter grade"? _____

What does service center do if exact wire size is not in inventory?

Burnout most common. Best if core kept under 650°F, but significantly higher OK with water suppression system, temp sensors in motor cores, and/or non-C3 coreplate.

Mechanical pulling at reduced temperature can be good. It is rare in U.S.

15 minimal; 25 good. Evidence of quick access to supplier desirable. An inverter grade wire is highly desirable for repair of motors powered by pulse width modulated ASDs. Obtain the brand and manufacturer specifications. Metric or 1/2 AWG necessary for metric motors.

On random wound motors, is winding pattern ever revised for reasons other than customer ordered re-design? ❑ Yes ❑ No

If yes, what changes?

❑ Lap to concentric

❑ Concentric to lap

❑ Other (explain)

Why are changes made?

Not desirable to revise pattern for convenience. A conversion from concentric to lap is often done, but should be avoided.

How many employees have the following years of experience?

_____ Over 8 years

_____ 4–8 years

_____ Under 4 years

Desirable to have 20% or more with over 4 years experience.

What sort of supplemental training or professional development activity is offered to service center employees? (Obtain evidence if possible.)

❑ In house training or structured mentoring (Describe)

❑ Off site short courses, workshops or seminars one or more days in length

❑ Subsidized evening or part-time classes at college or trade school

❑ Attendance at trade conferences or conventions

❑ Other

Participation in EASA trainings is commendable. Generally, any sort of training is desirable.

How much training or professional development do service center employees receive?

_____ Percentage of employees receiving off-site training annually

_____ Average days off site per year per employee receiving off-site training

_____ Annual training expenditure per employee receiving off-site training

At least 10% should receive annual offsite training.

One or more days off site desirable.

$300 or more per employee desirable.

In what trade or professional associations does service center have membership?

_____

EASA membership is a definite plus, although very large service centers may have in house capability to provide same benefits.

What temperature classes of insulation are stocked and used? _____

F or H desirable.

What (if any) kind of core loss testing does service center use?

❑ Loop or ring test; max kVA _____

❑ Commercial tester; max kVA _____

Any commercial tester is evidence that service center is conscientious about core losses. Loop testing per EASA guidelines may be comparable to commercial testers if performed correctly.

Are test records kept on permanent file? ❑ Yes ❑ No

How are results used? Check all that apply:

❑ Check for hot spots to be repaired

❑ Note watts per pound and compare to a standard

❑ Document impact of burnout/rewind to customer

Certainly check for hot spots. Noting watts per pound and comparison to standard or before and after testing is commendable.

Is no-load testing done on all motors? ❑ Yes ❑ No

This should be done. If not, determine why not.

Equipment Calibration

Users requiring a more detailed inventory of capability may refer to Appendix D, Quality Electric Motor Repair: A Guidebook for Electric Utilities.[1]

Item	*Normal interval*	*Date last calibrated or certified*	
Ammeters	_____	_____	Annual
Wattmeters	_____	_____	Annual
Core Loss Tester	_____	_____	Annual
Burnout oven temp.	_____	_____	Annual
Micrometers & Calipers	_____	_____	Annual OK; 6 months better. May be done in-house to certified clean dry standard blocks.

Surge Comparison Tester — Annual

Brand _____

Model _____

AC Power Supply

Voltage Range _____

kVA _____

Continuously variable voltage? _____

Annual on volts, amps, and power factor or watts unless these are monitored by the portable instruments above.

DC Power Supply

Voltage Range _____

kW _____

Continuously variable voltage? _____

Annual on volts, amps, and power factor or watts unless these are monitored by the portable instruments above.

What percent of motor rewind jobs get core loss testing both before and after rewinding? _____%

Ideally 100%. Explain lower percentages.

Varnish and resins

spec. _____

spec. _____

spec. _____

spec. _____

spec. _____

Sample should have been taken and analyzed every 2-3 months, to ensure no degradation from aging.

Manufacturer's material specs should be on file.

Vibration Analysis Equipment

Brand _____

Model _____

Annual
Hand held equipment is getting to be quite good.

High Potential Tester (HiPot)

Brand _____

Model _____

AC rating _____

DC rating _____

Six months to a certified standard resistance.

Notes:

Documents and Record Keeping

Check whether current copies of all the following documents are present:

- ❑ NEMA MG1 Motors and Generators
- ❑ NEMA RP 1 Renewal Parts of Motors & Generators
- ❑ AFBMA Std 7 Shaft & Housing Fits for Metric Radial Ball & Roller Bearings
- ❑ AFBMA Std 20 Metric Ball & Roller Bearings Conforming to Basic Boundary Plans
- ❑ ISO 1940/1 Mechanical Vibration - Balance Quality Requirements of Rigid Rotors Part 1
- ❑ ISO 2372 Mechanical Vibration of Machines with Operating Speeds From 10 to 200rev/sec
- ❑ ISO 9000, -1, -2, -3, -4 Quality Management and Quality Assurance
- ❑ IEEE Std 43 Insulation Resistance Testing
- ❑ IEEE Std 112 Polyphase Induction Motor Testing
- ❑ IEEE Std 113 Test Procedure for DC Machines
- ❑ IEEE Std 432 Insulation Maintenance
- ❑ IEEE Std 1068 Petroleum & Chemical Industry Motor Repair(1)
- ❑ UL 674 Rebuilding Explosion Proof Motors(1)
- ❑ EASA Technical Manual(2)
- ❑ EASA Winding DATA(2)
- ❑ EASA Warranty(2)
- ❑ EASA Standards(2)

(1) Not applicable for service centers which do not serve this market
(2) Non EASA members should produce equivalent documents or file material.

*How long does service center keep records on each repaired motor?*_____
(Obtain sample copy of filled in job card or computer printout.)

Reference:
1 Quality Electric Motor Repair: A Guidebook for Electric Utilities. This document, prepared by Washington State Energy Office, was originally co-sponsored and printed by Bonneville Power Administration as DOE/BP-2747 and Electric Power Research Institute as EPRI TR-105730s. The Bonneville Power printing is available free to Motor Challenge partners.

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