

## Case Study Slightly Loose Bearing Fits and VFD Issues in Vertical Motor with EMPATH Electrical Signature Analysis

Howard W Penrose, Ph.D., CMRP  
President, MotorDoc® LLC

In-place testing was performed on a 350 horsepower, 460 Vac, 1780 RPM vertical motor (Figure 1) and EMPATH detected conditions associated with bearings, rotor and early winding stress were indicated. The motor was removed for routine overhaul and the defects were investigated.



*Figure 1: 350 horsepower electric motor prior to disassembly.*

The defects shown in the following test results followed by the observations and measurements. EMPATH identified the following:

- Drive end bearing defects.
- Loose fits on journals, journals have ceramic insulation.
- Windings intact, but dirt and prior repairs result in winding stress and partial discharge. These also indicate incorrect VFD settings.

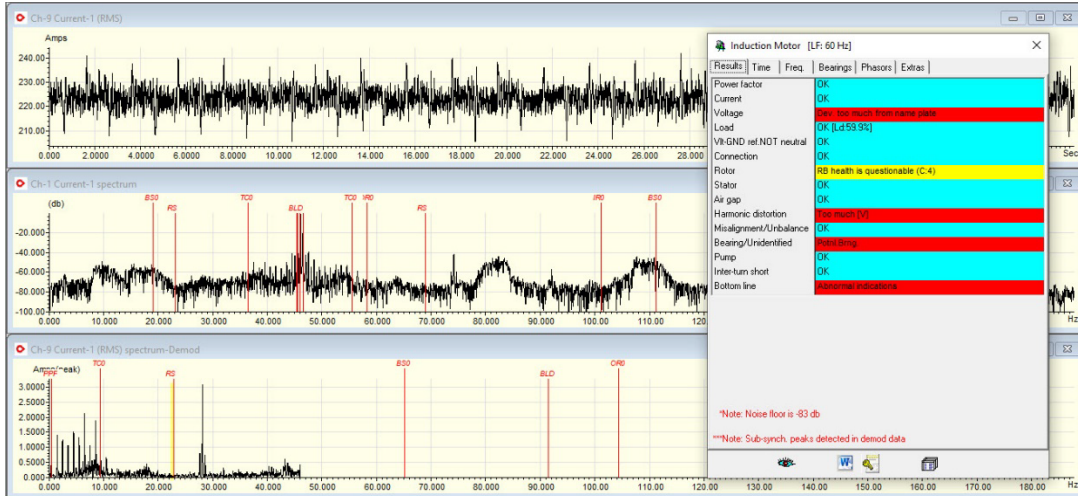


Figure 2: Automated fault detection of EMPATH ESA.

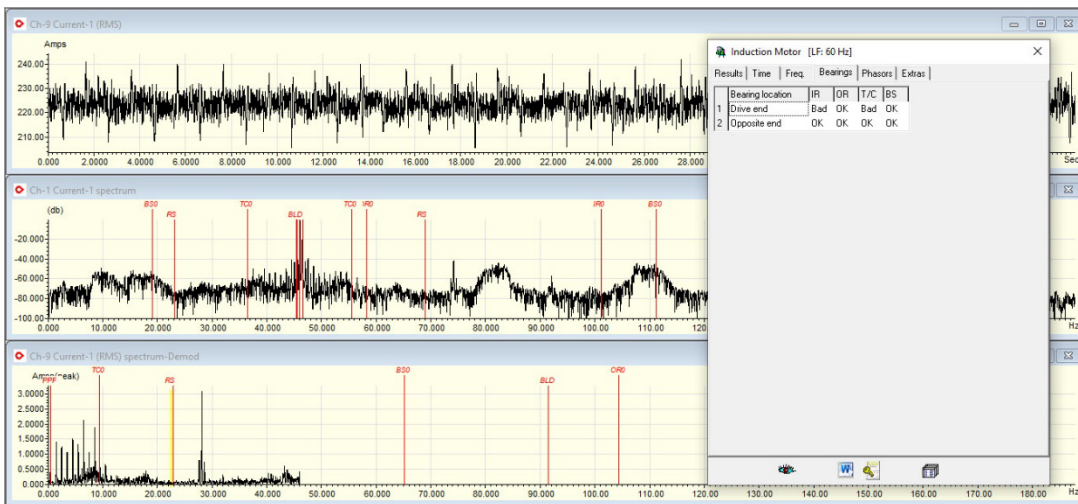


Figure 3: EMPATH detection of bearing components.

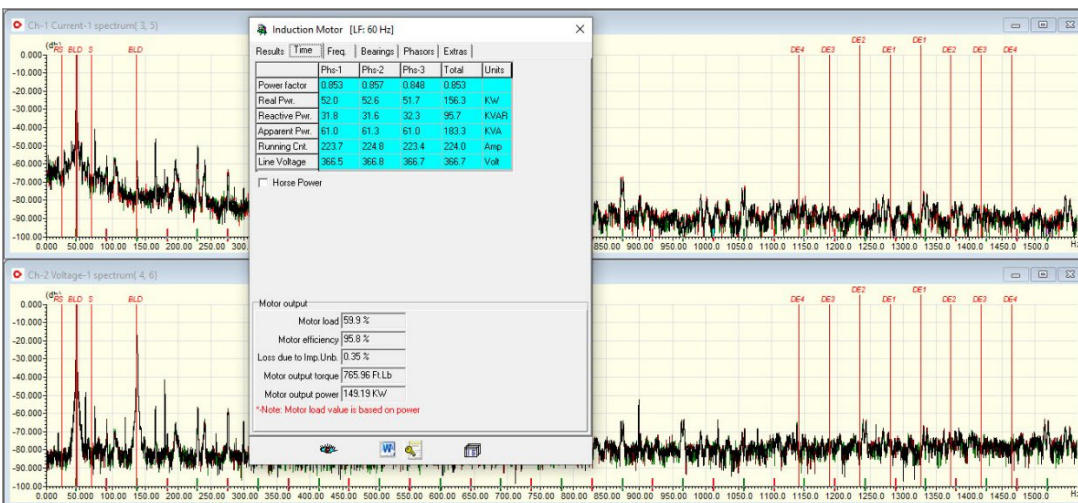


Figure 4: Low level dynamic eccentricity due to loose fits and rotor condition.

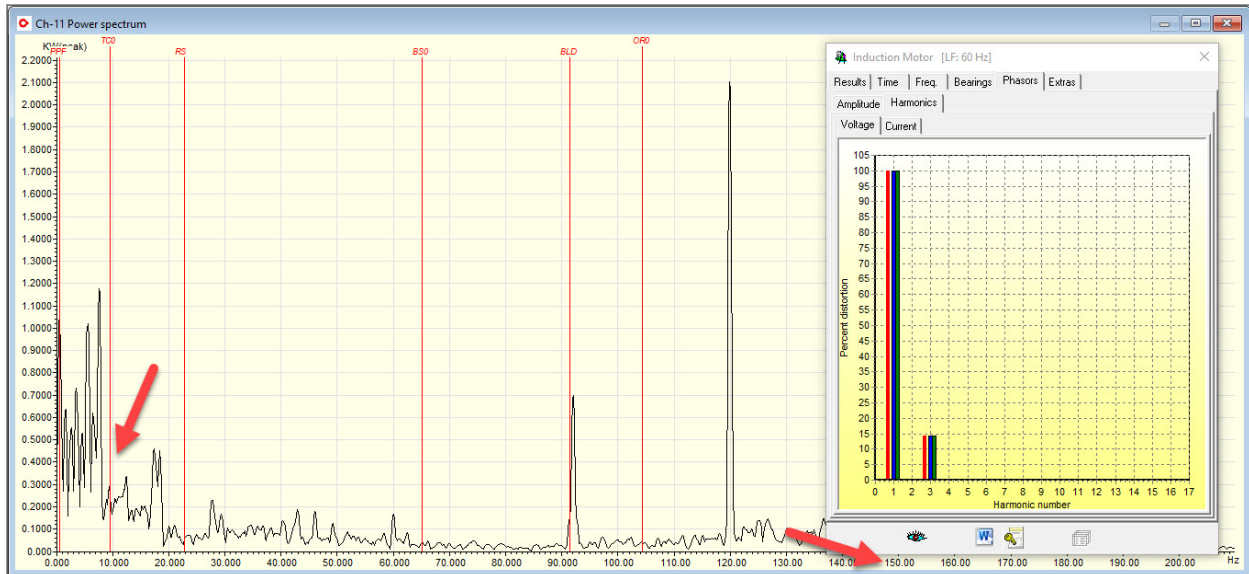


Figure 5: Excluding impellor rubbing (peaks on the left), bearings, loose fits, dynamic eccentricity, and winding stress losses are at least 4.35 kilowatts.

At the time of testing the motor was operating at an input of 156.3 kilowatts which means that the losses represent 2.8% of the load. This represents early detection and 38,110 kWh per year with the projected emissions at a minimum of 27 metric tonnes CO<sub>2</sub>. Following are the post disassembly findings for the bearings.



Figure 6: Drive end bearing - partial disassembly.

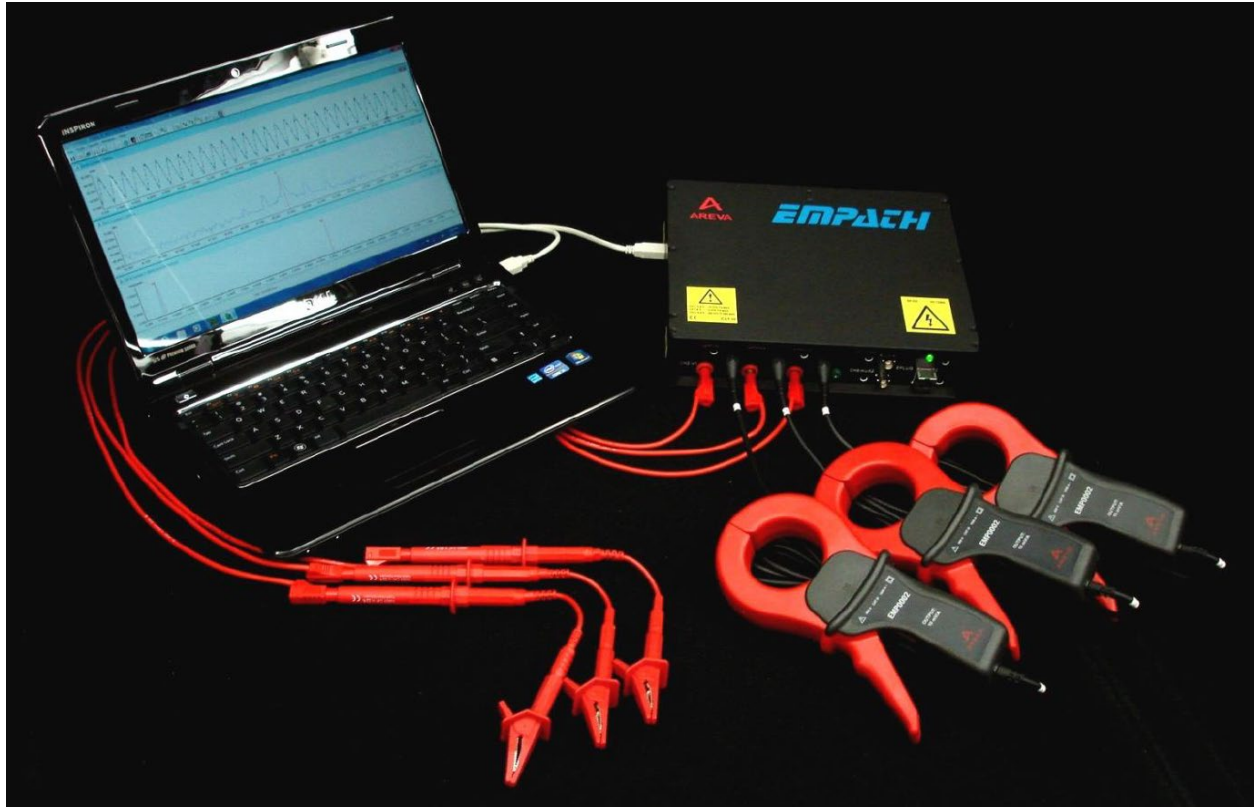


Figure 7: Removed bearing and bearing journal with ceramic.

SHAFT JOURNALS				SHAFT EXT	DE	ODE	SHAFT JOURNALS			
1) SHAFT EXTENSION	2.7525	PASS	GOOD	TAPERED	NO	NO	5) SHAFT EXTENSION	2.9993	PASS	GOOD
COUPLING ID	N/A	CLRNC		THREAD COND	N/A	PASS	FAN FIT	3.0012	CLRNC	.0019
2) OB SEAL JOURNAL	2.7525	PASS	OUT OF ROUND	LCK NUT COND	N/A	PASS	6) OB SEAL JOURNAL	6.9361	N/A	N/A
OUTBOARD CLEARANCE	.0161			LCK NUT SIZE	N/A	N-14	OUTBOARD CLEARANCE	.0325		
3) BEARING JOURNAL	2.9525	FAIL	UNDERSIZED	KEYWY COND	N/A	PASS	7) BEARING JOURNAL	4.3305	FAIL	UNDERSIZED
MINIMUM	2.9529	MAX	2.9534	KEYWAY SIZE (L x W x D)			MINIMUM	4.3312	MAX	4.3318
4) IB SEAL JOURNAL	3.8394	PASS	GOOD	N/A x N/A x N/A		DE	8) IB SEAL JOURNAL	3.2880	PASS	GOOD
INBOARD CLEARANCE	.0399			3.5" x 0.5" x 0.25"		ODE	INBOARD CLEARANCE			
INSPECTION COMMENTS										

Figure 8: Bearing journal measurements.

On a first 48 second test on a VFD driven vertical motor with an EMPATH ESA data collector mechanical and electrical defects were found in an electric motor and pump. The defects were found early and represented additional losses of 2.8% of the load, 38,110 kWh/year and 27 metric tonnes of CO2/year. As the surfaces were ceramic coated, the as-found looseness would have existed since the prior work that involved applying the coating. The use of EMPATH as part of post-repair quality control can identify these conditions before accepting the motor into your application.



For more information contact MotorDoc® LLC at [info@motordoc.com](mailto:info@motordoc.com) or visit <https://empathcms.com>.