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EMPATH™

Electric Motor Performance
Analysis & Trending Hardware

MotorDoc® LLC

Doing what everyone else just talks about

Case Study

Evaluation of a Cooling Tower Motor, Gearbox, Blades and Power Quality

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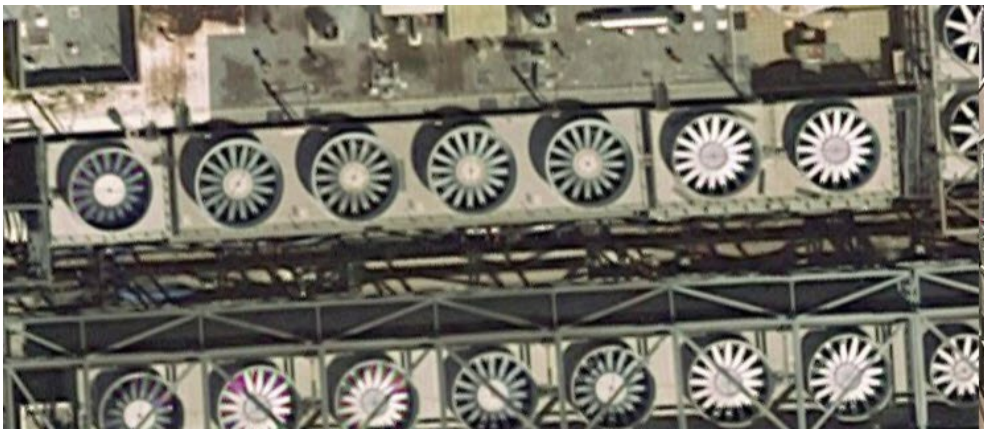

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Case Study: Evaluation of Cooling Tower Motor, Gearbox and Blades with Electrical Signature Analysis

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www.EmpathCMS.com and www.motordoc.com

Following a VFD failure on a cooling tower application, Electrical Signature Analysis (ESA) was performed with the equipment in bypass in order to evaluate the condition of the system from power quality to the blades. ESA has the capability of detecting all components of a system from incoming power to driven equipment.

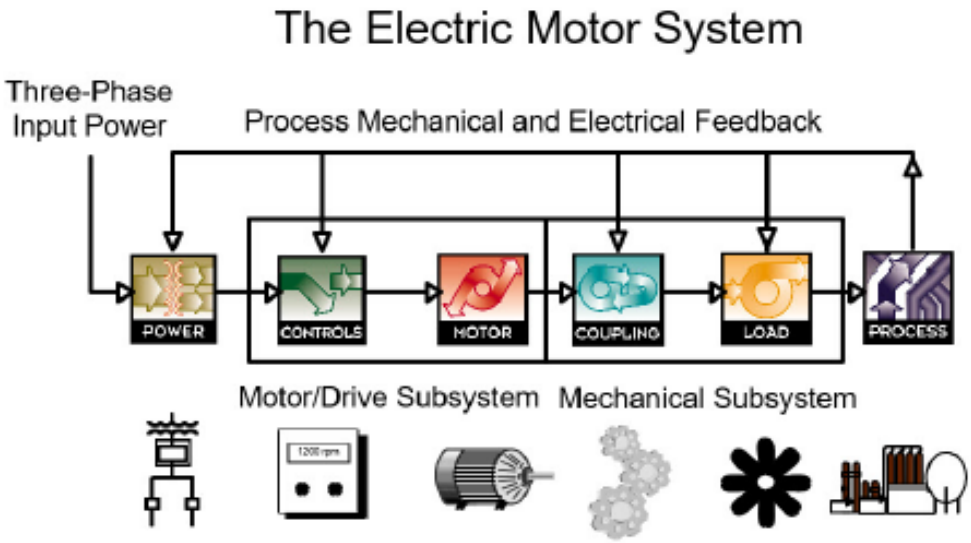

Figure 1: Map of a Typical Motor System Arrangement

Connections were made inside the drive cabinet and data was collected during operation of the cooling tower while awaiting a replacement drive.

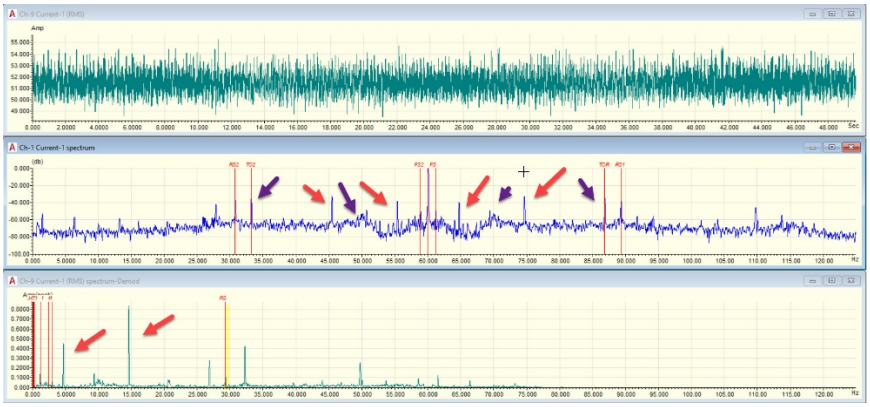

Figure 2: Low Frequency ESA Using EMPATH(tm) Software

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The cooling tower consisted of an electric motor, drive shaft, right angle gearbox and blades. The motor information was found in the EMPATH database, which provided rotor bars and stator slots.

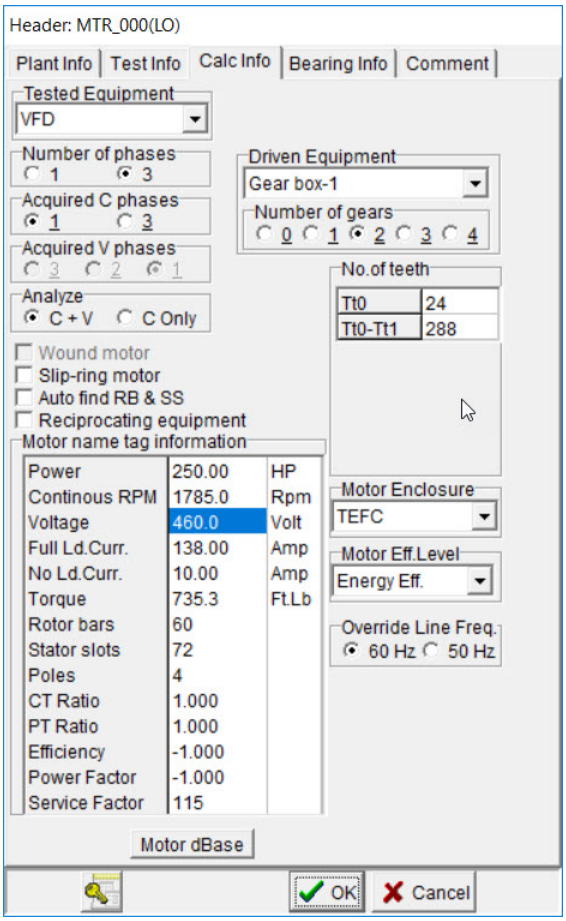

Figure 3: Motor Nameplate Information in EMPATH software

The issues identified in Figure 2 include a high 1X RPM which would be related to the misalignment found across the drive shaft from the motor to the gearbox. The peaks on either side of line frequency are at the output speed of the gearbox and the red arrows are indicators of blade issues. An investigation identified that the hub was eroded and the blades were loose as a result. The gear frequencies identified excessively worn gears in the gearbox, which was replaced. This had also been confirmed with EMPATH Torsional Analysis, as show in Figure 4.

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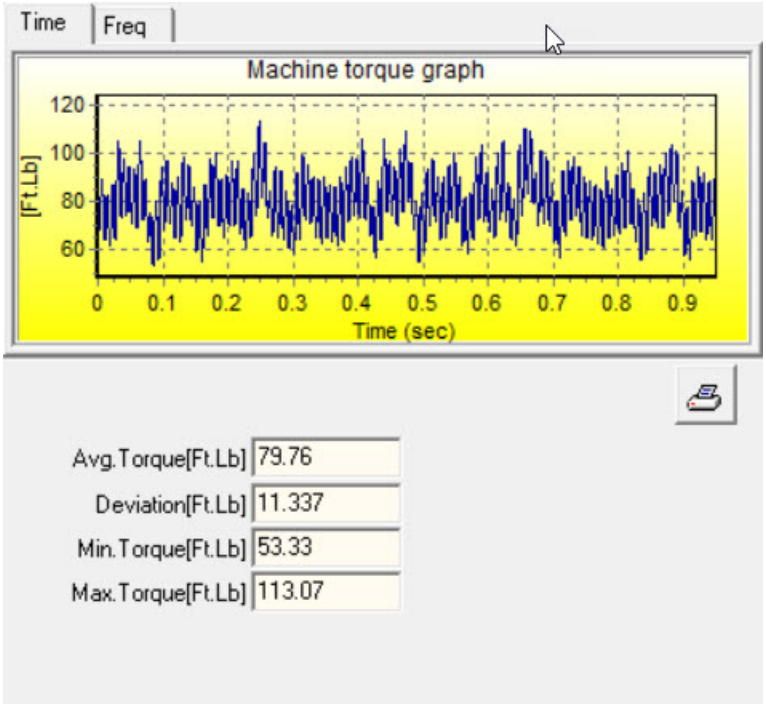

Figure 4: Erratic torque related to the gearbox and alignment

A few additional issues found during the investigation included current harmonics that resulted in a reduced True Power Factor (0.53 PF), which will result in the motor generating excessive heat. The cause can be seen in current notching that was found to be from elsewhere in the system.

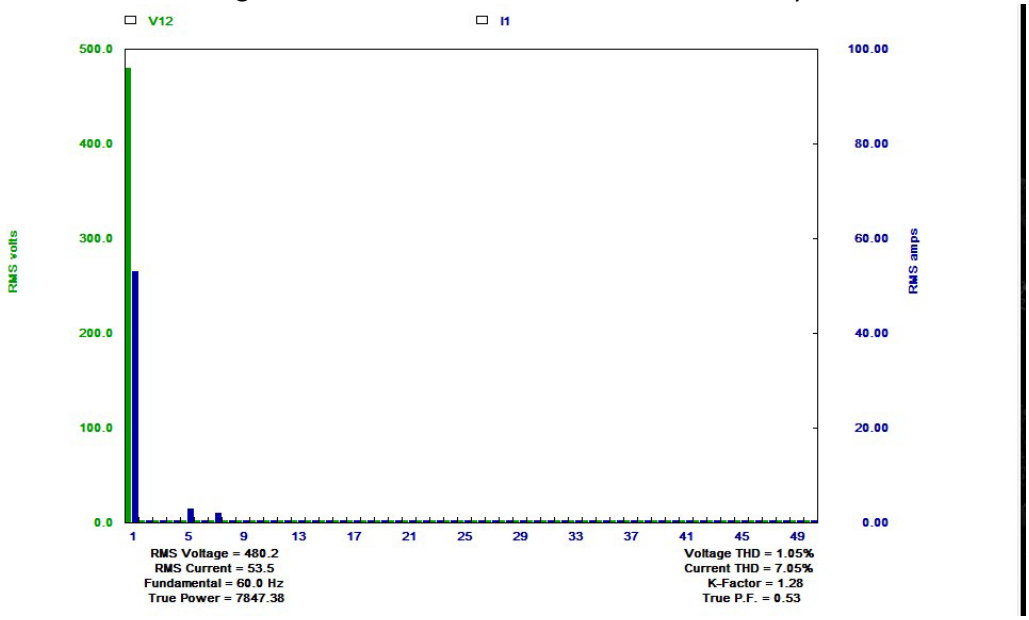

Figure 5: Harmonic Analysis of the system using a Summit Power Analyzer (PS 4550)

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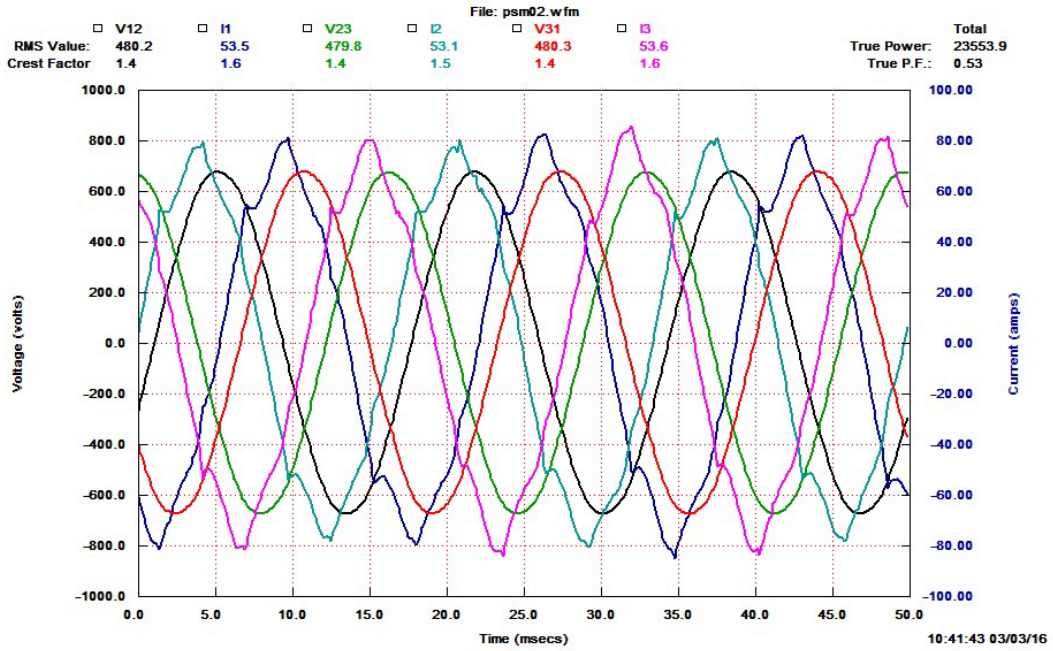

Figure 6: Current notching causing 5th and 7th harmonic the current notching is found through the entire electrical system

Conclusion:

Even with a single set of data, EMPATH™ ESA can detect issues from incoming power to driven equipment. This case involves a power quality issue, electric motor faults, gearbox gear issues and a defective hub resulting in loose blades. A majority of issues are detected using smart diagnostics.

For more information contact us at info@motordoc.com or ask for Charlie at 800 919-0156 ext 102 in the USA. Continuous monitoring systems are available as well as portable analyzers.

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EMPATH™

Challenge

Electric motors and mechanical systems are subject to deterioration and damage that can suspend operations, leading to expensive repair and downtime.

Solution

Framatome offers the Electric Motor Performance Analysis & Trending Hardware (EMPATH™) system to conveniently measure and analyze electric motor current and voltage to obtain information on critical processes and equipment. EMPATH helps owners detect potential motor problems early, enabling timely repairs and avoiding serious damage.

The key to EMPATH's successful track record is its utilization of Motor Current Signature Analysis (MCSA) technology.

The Theory of MCSA

When an electric motor drives a mechanical system, it experiences variations in load caused by gears, pulleys, friction, bearings, and other conditions that may change over the life of the motor. The variations in load caused by each of these factors in turn cause a variation in the current supplied to the motor. These variations modulate the carrier frequency.

EMPATH utilizes a unique process to demodulate the signal from the carrier and present an unambiguous spectral display. Using normal and demodulated data permits analysis of not only the motor but also the load and the supplied power.

The EMPATH System

The EMPATH system consists of a laptop computer with our exclusive signal conditioning board. Analysis software stores data and gives a readout of the time and frequency signatures. The signal conditioning board collects data on all three phases of voltage & current and provides MCSA-filtered signals. Also, two general-purpose input channels give the customer the option of collecting additional data simultaneously (such as vibrations, temperature, pressure, etc.).

Your performance
is **our** everyday **commitment**

Customer benefits

- EMPATH hardware is CE qualified.
- EMPATH provides unique algorithms that can reliably detect the early stages of rotor bar failures in induction motors.
- EMPATH saves time and precludes plant walkdowns by monitoring plant motors and driven machinery from a central motor control center.
- Auxiliary channels allow acquisition and analysis of data from a variety of other sources such as accelerometers (vibration data collection), proximity probes or process measurements. This information, properly analyzed, can greatly enhance a predictive maintenance program.
- The EMPATH System permits data acquisition and analysis of not only AC induction motors but also DC motors, synchronous motors, generators and transformers. Efficient energy utilization is also indicated by the EMPATH analysis routines.

Technical Design

The EMPATH software provides spectral analysis of all inputs.

Inputs

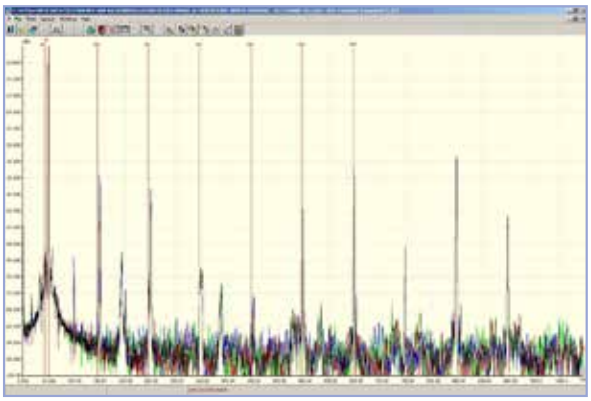
- Three Phases of Current (A,B,C)
- Three Phases of Voltage (A,B,C)
- Two Auxiliary Inputs (± 5V)

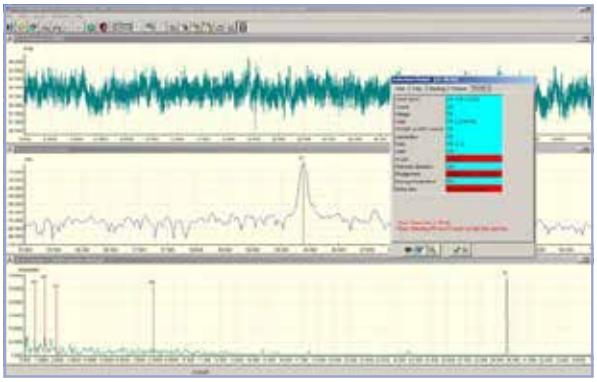
Outputs

- Three Conditioned Currents (A,B,C)
- Three Conditioned Voltages (A,B,C)
- Phase A RMS Current Level
- Phase A RMS Demodulated MCSA Signal
- Two Isolated Auxiliary Signals

Software

- Automatically marks traces
- Automatically tunes acquisition hardware for the incoming signals
- Adjusts sampling frequency and length of input sample
- Displays time and frequency data with cursors to read actual values
- Retrieves past data and compares with present data via plot overlays
- Comes with built-in
  - Tracking and trending database
  - Motor and bearing database
  - Motor enclosure and efficiency database
- Fully compatible with the existing data
- Fully compatible with Windows-XP, VISTA, Windows-7 and Windows-10 OS
- Fully compatible with Framatome's Continuous Motor Monitoring System (CMMS)





In the "High Frequency" data, EMPATH provides three phases of current and voltage and their associated spectra. An automatic on-screen assessment of the motor health is performed immediately after the data acquisition.

EMPATH indicates:

- Rotor bar deterioration
- Rotor eccentricity
- Stator phase imbalance
- Motor speed and slip
- Gear and belt imperfections
- Average running current, an indicator of motor torque
- Numerical and graphical display of Torsional vibration and dynamic loading
- Bearing degradation

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E-Plug Enhances Motor Analysis Safety

Challenge

Ensuring safety during operations is paramount at nuclear power plants. During motor analysis, opening a 460 or 480-volt motor control center cabinet door while equipment is energized has inherent dangers requiring protective clothing and qualified personnel.

Solution

Convenient and Practical
Framatome's E-Plug hardware permits the acquisition of motor electrical signature analysis data at a motor control center (MCC) — without opening the MCC door. The user simply attaches a connector to the door, while cable from the innovative E-Plug module passes voltage and current data from probes inside the MCC to the connector. The connector then mates with a cable that permits direct feed into EMPATH 2000, expediting electrical signature analysis.

The E-Plug's efficient design comprises an enclosure with external attachment leads. Both current and voltage signals pass through these leads. Inside the enclosure, electronic circuitry processes the signals to prepare them for output to the through-door connector. In short, E-Plug contains everything you need for efficient signal transmission.

Customer benefits

- Enhances safety by avoiding exposure to potential dangers associated with opening a 460 or 480-volt cabinet door while equipment is energized
- Precludes both the need for protective clothing and the attachment/removal of probes inside the MCC
- Simplifies connections, requiring only one cable to perform testing
- Reduces overall testing time
- Convenient to use. Eliminates probe handling when performing tests
- One person can perform online motor testing with EMPATH 2000
- Fully compatible with Framatome's new generation Continuous Motor Monitoring System (CMMS) platform

Your performance
is **our** everyday **commitment**

Inputs to the E-Plug Module

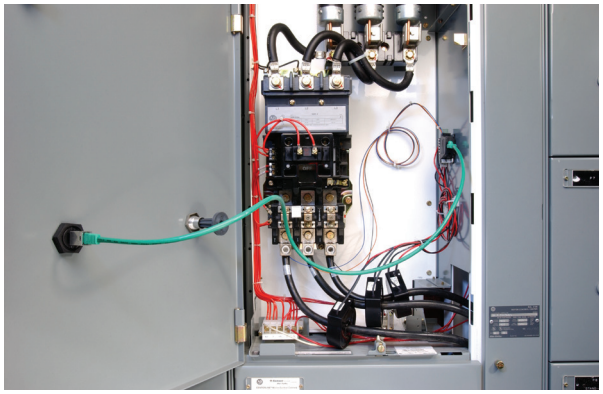
Power cables to the motor pass through current transducers (CTs) that measure the current flowing through the cable and produce a voltage output proportional to the current flowing to the motor. The voltage output from the current transducers is typically tens of milli-volts per amp, yielding an upper limit of 10 Vac for the current transducer output.

Fused wires attached to the power cables provide a voltage signal to the E-Plug module. For supplied power up to 600 Vrms, the E-Plug module will be directly connected to the voltage signal. For supplied power above 600 Vrms, output from existing potential transformers (PTs) will step the voltage down to 120 Vrms prior to feeding to the E-Plug Module.

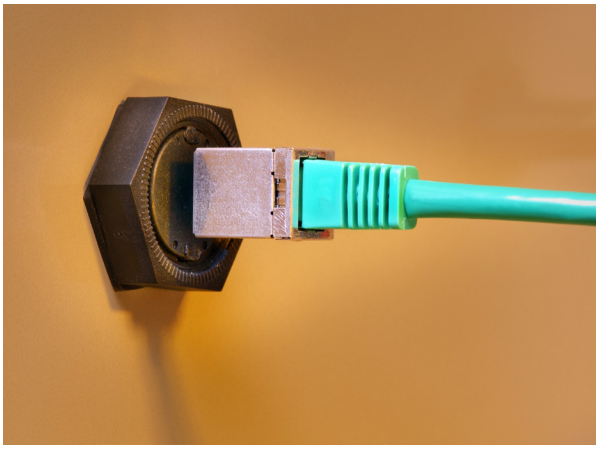
For both voltage and current measurements, the frequency response is DC to 5000 Hz, minimum.

Outputs From the E-Plug Module

The outputs from the E-Plug Module to the MCC through-door connector are 5 Vac peak for both current and voltage, limiting external voltages at the MCC door to 5 Vac peak. All outputs from the E-Plug Module provide a frequency response from DC to 5 kHz. The accuracy of all outputs is +/- 3%.



E-Plug's design contains everything you need for efficient signal transmission.



E-Plug simplifies motor analysis and enhances safety.

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